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FORTY-SECOND PROGRESS REPORT OF THE FIRESTONE TIRE & RUBBER COMPANY ON BATTALION ANTI-TANK PROJECT

UNDER

Contract Nos. DA-33-019-ORD-33
DA-33-019-ORD-1202

ORDNANCE DEPARTMENT PROJECTS
TS4-4020—WEAPONS AND ACCESSORIES
TM1-1540—AMMUNITION

COPY No. 52

THE FIRESTONE TIRE & RUBBER COMPANY
Defense Research Division
Akron, Ohio

JANUARY 1954

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FORTY-SECOND

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

BATTALION ANTI-TANK PROJECT

Contract Nos.
DA-33-019-ORD-33 (Negotiated)
DA-33-019-ORD-1202

RAD Nos. ORDTS 1-12383
ORDTS 3-3955
ORDTS 3-3957
ORDTA 3-3952

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

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54AA-17430

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ABSTRACT

The Weapon System - The BAT 90mm test rifle No. 1 has been tested on the pendulum mount at pressures in excess of 115 percent of the rated maximum pressure. The test data are presented and discussed.

A charge development program was conducted for the BAT 90mm test rifle No. 1, as a part of a fin opening and spin test of the 90mm folding fin projectile. The test data are given.

The BAT 90mm Projectile - The theoretical estimation and experimental determination of a form factor for the BAT 90mm folding fin projectile are discussed.

A study of fin opening problems as related to this projectile was started and the test results are reported.

T119 Projectile - Two phases of projectile design, as related to this folding fin projectile, were investigated: (1) the effect of increasing the housing diameter to such a degree that it might serve, in effect, as a third bourrelet and perhaps minimize the shift of the projectile in the rifle tube, and (2) the effect of oversize fin hinge pin holes upon projectile accuracy. The data from both investigations are presented.

Penetration Studies - A program was conducted to study the effect of rotation upon standoff-penetration behavior. The test data are presented and the results are discussed.

Fuzes - A study of methods of improving the graze sensitivity of the T222 fuze assembly has continued. A "potted lucky" design was tested in this report period and test results are given.

A quantity of T267E14 fuzes are being assembled for test firings.

A device for producing prematures in electrically fuzed HEAT shell, as an aid in a general study of prematures, has been designed and will be tested.

The design of a point detonator assembly for the T317MT fuze is illustrated and discussed.

Proof Acceptance Test, 90 mm. Test Rifle No. 1

The 90mm test rifle No. 1 has been proof tested on the pendulum mount at pressures in excess of 115% of the rated maximum pressure of 17,206 psia which was discussed in the Forty-First Progress Report, December, 1953. The test data are presented in Table I.

Round No. 6533 was a modified DRC669 proof slug weighing 11.5 $^{\pm.1}$ lb. (Fig. 1) assembled with a modified T52 polyethylene case liner, M57 percussion primer, and 105mm cartridge case, T53E1, which had been necked down to 90mm size.

Rounds Nos. 6719 and 6720 were DRC 758 proof slugs weighing 12.0 $^{\pm.1}$ lb. (Fig. 2) assembled with modified T6 polyethylene case liners, M57 percussion primers, and 105mm Cartridge Cases, T53E1, which had been necked down to 90mm size.

Table I
Proof Acceptance Test
90 mm. Test Rifle No. 1

Round No.	Proj. Wgt. (lb.)	Charge Wt.* (lb.-oz.)	Chamber Press. (M3 Cu)(psi)**	Velocity Instr.(fps)	Recoil (lb-sec)	Flow Ring
6533	11.58	7-13	16,850	2375	9.9	20°
6719	11.95	7-13	18,600		4.2	0°
6720	11.95	7-11	17,550		2.8	0°

* Propellent RAD 16415, MP, M5, .040 - inch web

** Average of two gages

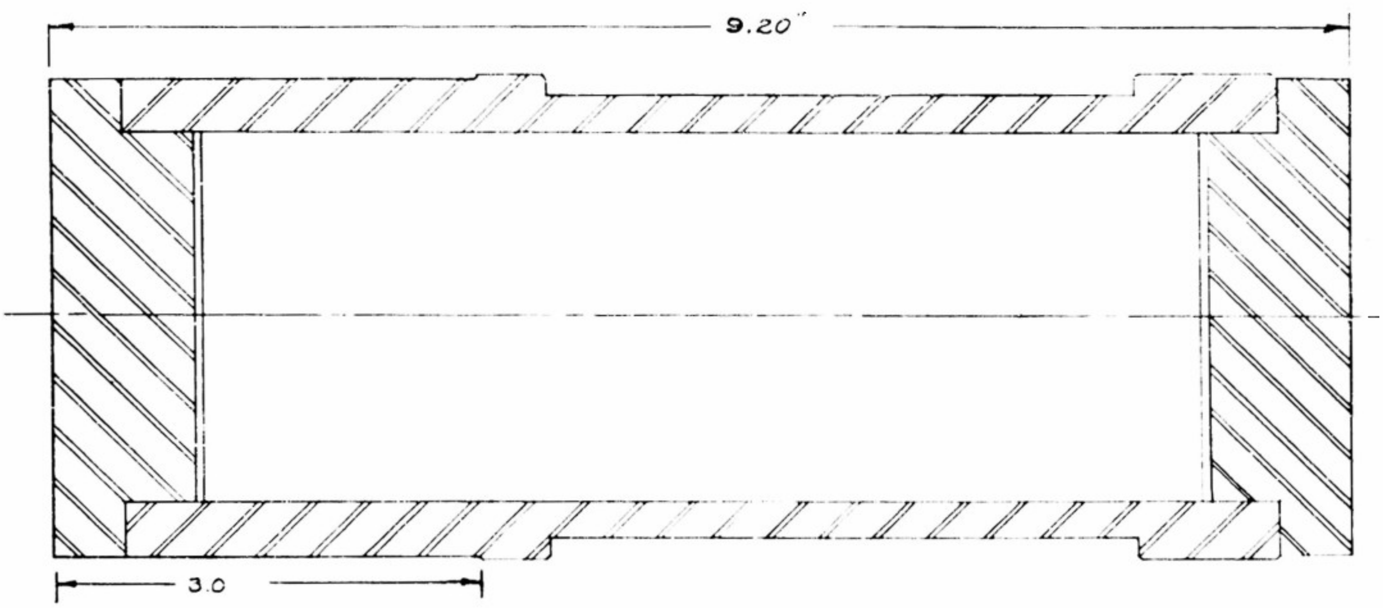


Fig. 1. Modified DRC669 Proof Slug.

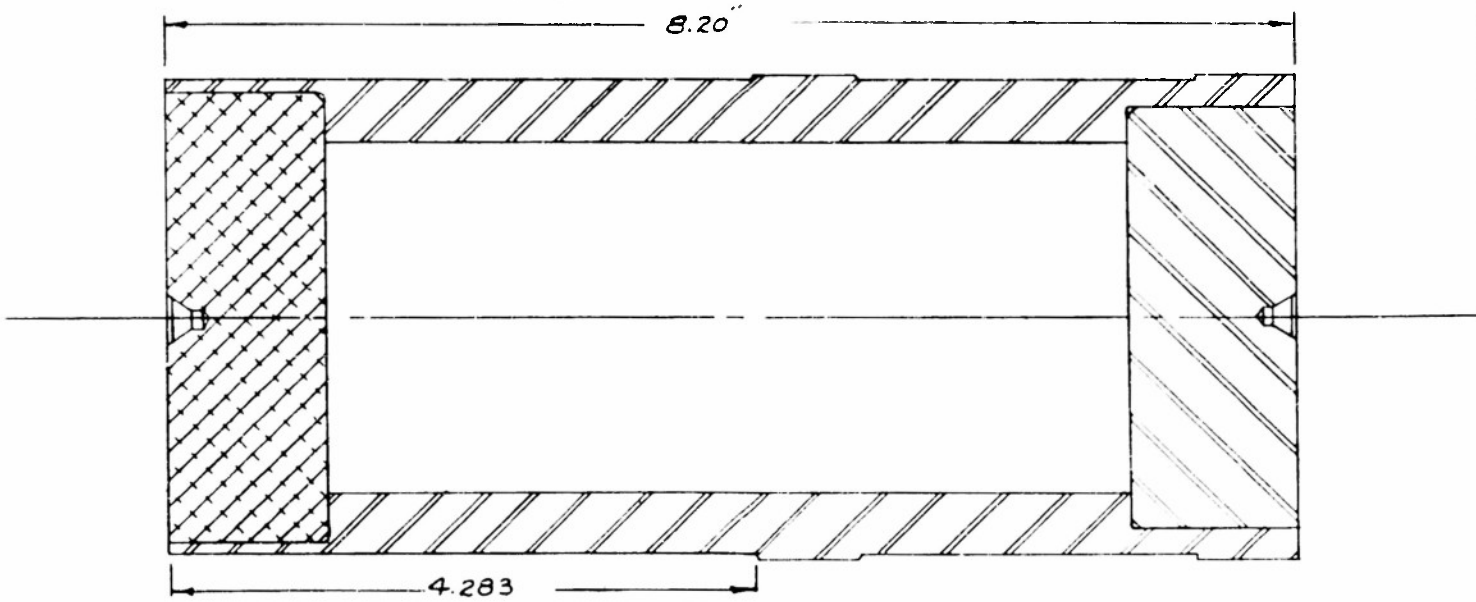


Fig. 2. 90 mm. Proof Slug.
Firestone Dwg. No. DRC758.

The higher pressures for rounds No. 6719 and 6720 are attributed to the greater projectile weight (11.95 lb. compared to 11.58 lb.) and also to the decrease in chamber volume of approximately 20 cu. in. (5%) resulting from the use of the 0° flow ring and the DRC758 proof slug. This combination occupies a greater volume of the chamber than the 20° flow ring and the modified DRC669 proof slug. The forward recoil of round No. 6533 is probably due to the 20° flow ring which offers less gas flow interference at the vent entrance section than the 0° flow ring. (Forty-First Progress Report).

Charge Development, 90 mm. Test Rifle No. 1

A charge development program was conducted as a part of a fin opening and spin test of the 90mm folding fin projectile, using propellent RAD 16415, MP, M5, .040-inch web in the 90mm test rifle No. 1 with a 0° flow ring. The projectiles, with blunt noses and two rubber "O" ring obturators weighed 12.0 $\pm$.1 lb. and were assembled with modified T6 polyethylene case liners, M57 percussion primers and 90mm cartridge cases (DRF80). The test data are shown in Table II.

Pressure-charge relationships are shown in Fig. 3 for the 90mm folding fin projectile and also for modified DRC 669 test slugs (data reported in Fig. 3, Thirty-Ninth Progress Report, October, 1953). The method of least squares was used to obtain the best straight line fit of the data. Projectile velocities were not obtained because of instrumentation difficulties.

Table II
Charge Development
90 mm. Test Rifle No. 1

Round No	Projectile Wgt (lbs)	Charge Wgt.* (lb. oz)	Chamber Press (M3Cu)(psi)**	Recoil (lb-sec)
6651	11.95	6-13	14,200	17.0
6652	12.13	6-13	14,350	12.7
6653	12.14	6-9	12,900	9.9
6654	11.95	6-8	11,800	14.2
6655	12.14	6-12	13,950	17.0

* Propellent RAD 16415, MP, M5, .040-inch web

** Average of two gages

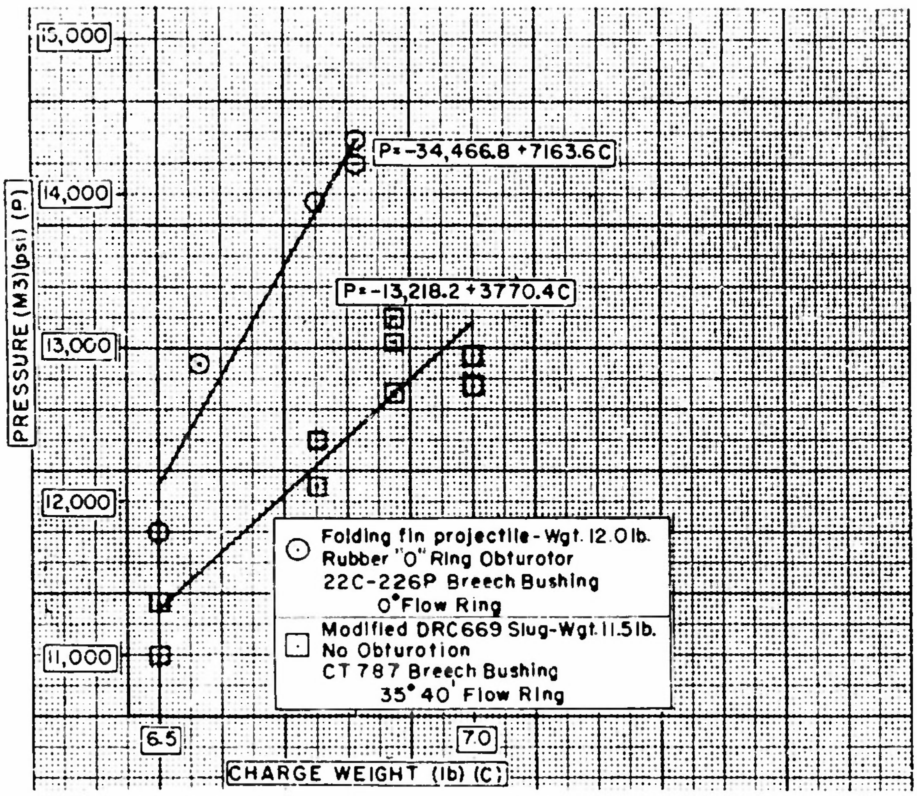


Fig. 3. Pressure - Charge Relationships.
Propellent RAD16415, MP, M5, .040-inch Web.
90 mm. Test Rifle No. 1.

The large difference in pressure-charge coefficients, 7163.6 psi/lb for the 90mm projectile compared to 3770.4 psi/lb for the proof slug (see Fig. 3), is probably due to the higher loading density, increased projectile weight (11.5 lb. to 12.0 lb.) and obturation of the 90mm projectile. The higher loading density results from a decrease in chamber volume of about 30 cu. in. The chamber volume was decreased by the use of the 0° degree flow ring, the 90mm projectile, and the DRF 80 cartridge case all of which occupy more of the chamber volume than the 35°40' flow ring, proof slug and modified T53E1 cartridge case.

Future Program

1. Effect of Obturation of Proof Slug on Interior Ballistics of 90mm Test Rifle No. 1.

Proof slugs with annealed copper obturating bands (DRB-15-1031) Fig. 4, and with grooves for the rubber "O" ring obturator (DRB-15-1032) Fig. 5 have been designed. DRC758-1 proof slugs will be modified to produce the above designs. The proof slugs with copper obturating band, rubber "O" ring obturator, and no obturation will be fired to determine the effect of the obturators upon the interior ballistics of the 90mm test rifle No. 1. The effects of variable loading density will be eliminated by using the same flow ring, cartridge case, and position of proof slug in the chamber throughout the experiment. A forcing cone will be placed in the 90mm test rifle in order to consistently position the test slugs with obturating bands.

2. Install piezo pressure stations in the 90mm test rifles No. 1 and No. 2.

3. Obtain pressure data to determine a Piezo/M-3 Copper conversion factor for the 90mm test rifles.

4. Obtain pressure-time curves with various propellents in the 90mm test rifles.

5. Obtain pressure-time curves at low temperatures to assist in the design of the fin-opening mechanism of the 90mm folding fin projectile.

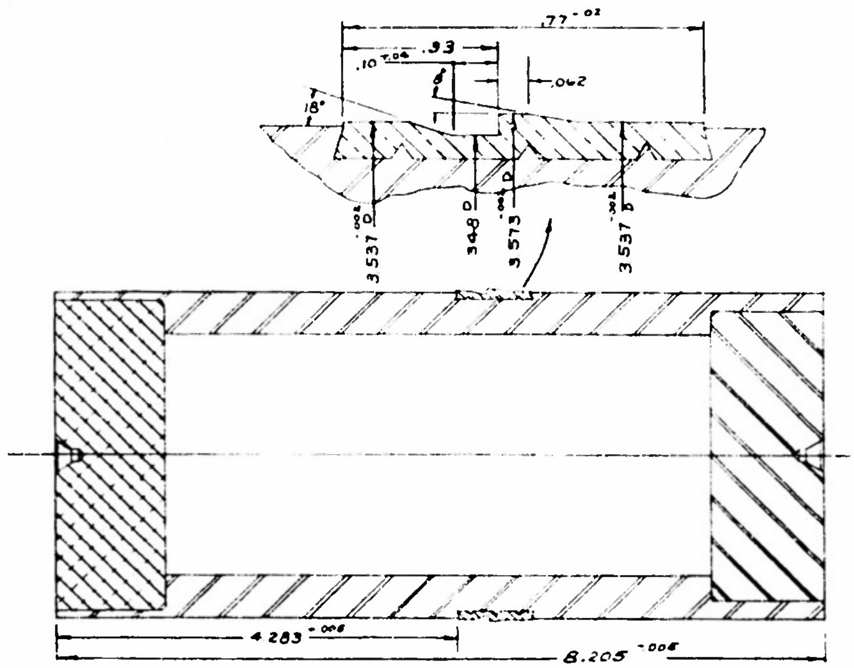


Fig. 4. 90 mm. Proof Slug (DRB-15-1031).
With Annealed Copper Obturating Bands.

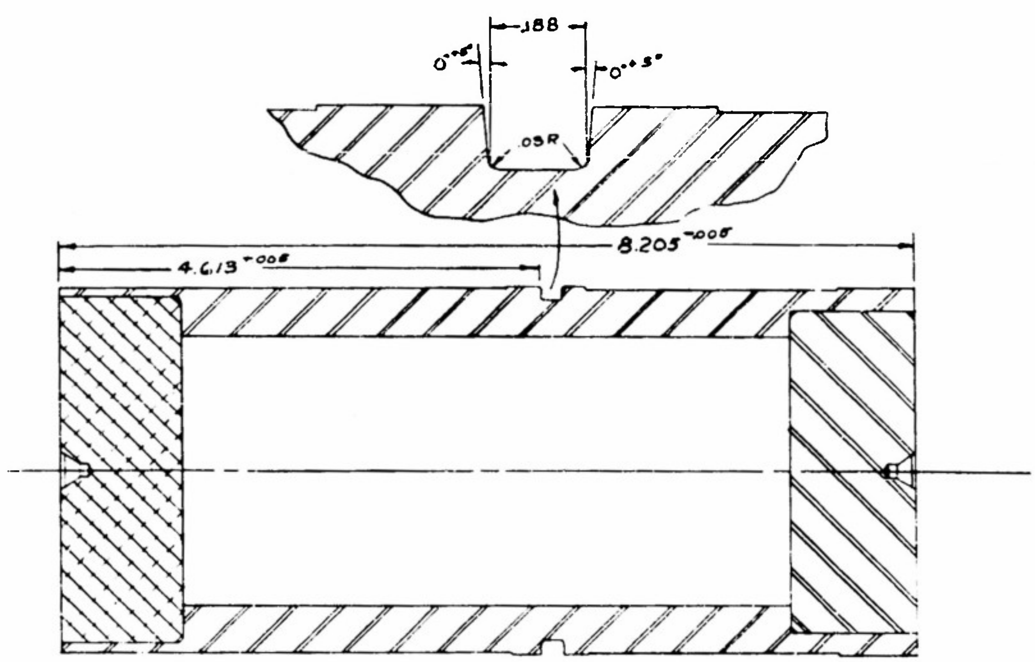


Fig. 5. 90 mm. Proof Slug (DRB-15-1032).
With Groove For Rubber "O" Ring Obturator.

Determination Of The Form Factor For The BAT 90 mm. Folding Fin Projectile

Theoretical Estimation

The design of the folding fin projectile for the BAT 90mm rifle is based upon that of the T119 105mm folding fin projectile. The conical head of the 90mm projectile is approximately one-half caliber longer than the conical head of the T119.

A form factor ($i_{2.2}$) of 1.43 based on the $G_{2.2}$ drag function has been estimated for the 90mm folding fin projectile. The ballistic coefficient ($C_{2.2}$) for the 90mm projectile weighing 12.0 lb. was calculated to be .67 from the equation:

$$C_{2.2} = \frac{m}{i_{2.2} d^2} \qquad (1)$$

where

$C_{2.2}$ = ballistic coefficient in lb/sq in

m = mass of projectile in lb

d = diameter of projectile in inches

$i_{2.2}$ = form factor

The above form factor for the 90mm projectile was estimated from the form factor for the T119 105mm projectile and from experimental data relating head drag and head length in BRL report No. 240, "Drag On Conical Heads", by H. P. Hitchcock. The form factor, $i_{2.2}$ =1.6187, was determined for the T119 105mm projectile in the Twenty-Fourth Progress Report. The head length of the T119 projectile is 2.033 calibers as compared with 2.5 calibers for the 90mm projectile.

The following relations for the total drag coefficient were used to estimate the form factor.

$$K_D = K_{DH} + K_{DF} + K_{DB} \qquad (2)$$

$$K_D = \frac{i_{2.2}}{\rho_o U \frac{1}{G(u)_{2.2}}} \qquad (3)$$

where

K_D = total drag coefficient

K_{DH} = head drag coefficient

K_{DF} = skin friction drag coefficient

K_{DB} = base drag coefficient

$i_{2.2}$ = form factor based on $G_{2.2}$ drag function

ρ_o = standard air density (5.217×10^{-4} lb/in^2/ft).

U = velocity of projectile (fps)

$G(u)_{2.2}$ = drag function (lb/in^2/sec)

The value of $K_{D_{2.033}}$ was calculated from equation (3) using the form factor of the T119 and Mach. No. 1.6 for which the experimental data were presented in BRL Report No. 240.

$K_{D_{2.033}}$ = .218 for T119 with 2.033 caliber conical head

$K_{DH_{2.033}}$ = .078 for 2.033 caliber head from BRL Report No. 240

$K_{D_{2.033}} - K_{DH_{2.033}}$ = .140 = $K_{DF} + K_{DB}$ from equation (2)

$K_{DH_{2.5}}$ = .053 for 2.5 caliber head from BRL Report No. 240

$\therefore$ $K_{D_{2.5}}$ = .193 for folding fin projectile with 2.5 caliber head

Table III
Firing Record
Proof Test and Ballistic Test, 90 mm. BAT Projectile

Purpose of Test: Proof Test & Ballistic Test of BAT 90mm Folding Fin

Ballistic Test Coil Distances: — 55.38' — 1 — 47.92' — 2 — 40.38' — 3 — 39.75' — 4

PROJECTILE

Model: 90mm Proj / DRC669 Slug
Type: Bat Folding Fin
Weight: 2 lb (Nom)
CG Location: ______
Bourrelet Dia: 3.537 [illegible]
Special Features: Blunt nose & ogive / Critical dia [illegible] / Two O Rings Parker 5430-14 & M3(Cu) Internal

Concrete Base Stake to Muzzle - 14'10½"
Base Line Stake to Muzzle - 33.5 ft
Zero Rdg 4.55# to target Center
Zero Rdg - 4.5# to target Top

Date of Test: January 18, 1954 / Erie Ordnance Depot

TEST GUN

Model: BAT 90mm
Type: 90mm Recoilless
Serial No: 1
Chamber: 8-4982-2
Bushing (Vent): 0° Flow Ring
Tube: 8-4443-11
Sighting Equipment: M17 Elbow Scope / 7183 Direct Sight
Mount: Pendulum - Proof Test and
Type: Rigid - Ballistic Test
Constant: 2.93 [illegible]

Temp - 33½°F Dry / 30°F Wet

MISCELLANEOUS DATA

Range: Down Range & 995 yd. Target
Propellant
Type: M5 MP Web: .040 in. Weight: Varies
Lot No: RAD 16415
Primer: M57
Shell Case: T53E1 modif
Liner: T6 modif
Temperatures
Magazine Max 73°F Min 71°F Present 71°F
Loading Room 54°F Ambient 21°F

Round No	Time of Flight (sec)	Proj Weight (lb.)	Powder Charge (lb-oz)	Wind Vel mph	Wind Dir degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Total Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Angle of Departure (mils)	Terminal Velocity (fps)	Retard Factor (fps/ft)	Observations
6719		11.95	7-13			18,900 18,300										DRC669 Slug in Pendulum Mt.
6720		11.95	7-11			[illegible]										DRC 669 Slug in Pendulum Mt.
6721 (4)	.59185	11.95	6-12	14	215	[illegible]		2172.0	15.7	½ mil R	-106	+19½	.120	—	.171	Fin Opening not measurable
6722 (1)	.58322	11.95	6-12	18	220	13,000 [illegible]		2194.4	16.95	¼ mil R	+4	+34¼	[illegible]	1619.0	.193	Fin Opening 8¾ x [illegible] in. Yaw 3½"
6723 (2)	.55456	11.95	6-14	13	215	14,000 13,900		2220.1	16.05	⅓ mil L	-71¼	+47	[illegible]	1668	.176	Fin Opening 8½ x 8½ x 8½ in Yaw 3 9/16"
6724 (3)	.56233	11.95	6-14	12	210	13,100 13,100		2219.2	16.05	½ mil L	-57¾	+13¼	[illegible]	1669.9	.178	Fin Opening 9⅜ x 9⅜ x 9⅜ in. Yaw 3⅝"
															Avg .180	

Air Dens. = 1249 x 10^-3 [illegible]

Proof Director: E. Huffman
Observers: R. Finucan, L. Sweebly, V. Lucas, W. Loye
Signed: M. Manofsky

The value of $i_{2.2}$ =1.43 was calculated from equation (3) using the value of $K_{D_{2.5}}$ =.193 at Mach No. 1.6. The value of the form factor was assumed to be independent of caliber size and projectile velocity.

Experimental Determination

A form factor ($i_{2.2}$ =1.34) and ballistic coefficient ($C_{2.2}$ =.71) of the BAT 90mm folding fin projectile were calculated from time of flight, terminal velocity, initial velocity, and angle of departure data obtained on four projectiles fired at a 1000 yard range. The experimental data are presented in Table III.

The time of flight was measured at a range of 3008 ft. and the terminal velocity was measured as an average value between 2991 and 3008 ft.

The Siacci theory and the $G_{2.2}$ drag function were used to calculate the ballistic coefficient of the BAT 90mm projectile. The following equations were used:

$$C_x = \frac{\rho x}{(S - S_o)} \tag{4}$$

$$C_{\theta_o} = \frac{\rho \sin 2\theta_o}{\left[\frac{A - A_o}{S - S_o} - I_o\right]} \tag{5}$$

$$C_t = \frac{\rho t}{\sec \theta_o (T - T_o)} \tag{6}$$

where

C = ballistic coefficient lb/sq in
ρ = ratio of air density to standard
x = horizontal range (ft)
θ_o = angle of departure (deg)
t = time of flight (sec)
S, S_o = Siacci space function
A, A_o =Siacci Altitude function
T, T_o = Siacci Time function
I_o = Siacci Inclination function

The subscript o denotes initial values.

Values of C were computed by substituting the proper values of experimental data and Siacci functions, determined from experimental data, in the above equations. Equations (4) and (6) were also used to determine a value of C by assuming various values of terminal velocity until the final values of the space and time functions were found which, along with the initial values, gave equal values of C ($C_x = C_t$) for both equations. The results of the calculations are presented in Table IV.

An average value of $C_{2.2}$ =.71, with a standard deviation of ± .02, was determined for rounds 6722-6724. The form factor, $i_{2.2}$ =1.34, was calculated from equation (1) using the average value of $C_{2.2}$ =.71, m=11.95, and d=3.537 in.

The calculated and experimentally determined values for both form factor and ballistic coefficient agree well within the value of experimental error.

Table IV
Results Of Calculations

Round No.	C_x	C_{θ_o}	C_t	C_x, C_t	Terminal Velocity Calculated * (fps)	Terminal Velocity
6721	--	--	--	.75	1638.5	--
6722	.69	.69	.69	.72	1639.0	1619.0
6723	.72	.69	.71	.74	1680.0	1661.8
6724	.73	.70	.73	.72	1664.5	1669.9

*Values which made $C_x = C_t$

Fin Opening Studies

In anticipation of fin opening problems which may arise during the development of the tail assembly of the BAT 90mm projectile, a fin opening study was planned similar to that followed in the T119 program. (See 40th Progress Report).

It has been established that fin-opening is dependent upon pressure, housing material, orifice diameter, shear ring thickness, and housing-stop interference. The housings of the first 50 BAT 90mm projectiles were made from 75S-T6 aluminum bar stock. An orifice diameter of .136 in. was calculated for a projectile chamber pressure of 6000 psi at the muzzle of the gun, and the shear ring thickness was set at .030 ± .005 in. The housing-stop interference was held between .0075 and .0115 in.

A group of these projectiles was fired for accuracy and the data were reported in the Forty-First Progress Report. Inspection of the target showed that the projectiles had fin openings in excess of the designed spread of 9.2 ±.2 inches.

To determine the cause for the excessive opening, two projectiles, similar to the group mentioned above except that one had a housing-stop interference of .0165 inch, were fired through a series of yaw cards into a recovery box. The range data are shown in Table V. The projectile with the housing-stop interference of .0075 to .0115 in. had a fin spread greater than ten inches while the projectile with the .0165 in. interference gave a normal fin opening.

These results indicate that an adjustment of the balance between orifice diameter and of the stop-housing interference was required. The orifice diameter was reduced to .113 in. from .136 in. and pistons with the .113 in. diameter orifice were assembled into five projectiles. The housing-stop interference was held at .016 in. The projectiles were fired through a series of yaw cards into a recovery box. The range data are presented in Table VI. Four gave normal fin opening and one gave a partial opening which was probably due to the low pressure.

Sixteen projectiles of this type were then fired for accuracy at an 18 ft. by 18 ft. target at 2000 yards. The range data are presented in Table VII. The first round hit the target and a total of nine hits were recorded. Probable errors of dispersion were not computed. Examination of the target impacts showed that the fins of five rounds had opened only partially. It is evident that a satisfactory balance of orifice diameter and interference was not attained.

It is planned to alter the fin design to enable it to absorb a wider range of opening stresses. Under conditions of excessive opening stress the fins have failed at the tooth form as shown in Fig. 6. The tooth form will be moved away from the end of the fin and an increase in thickness of the fin at the tooth form is also being considered.

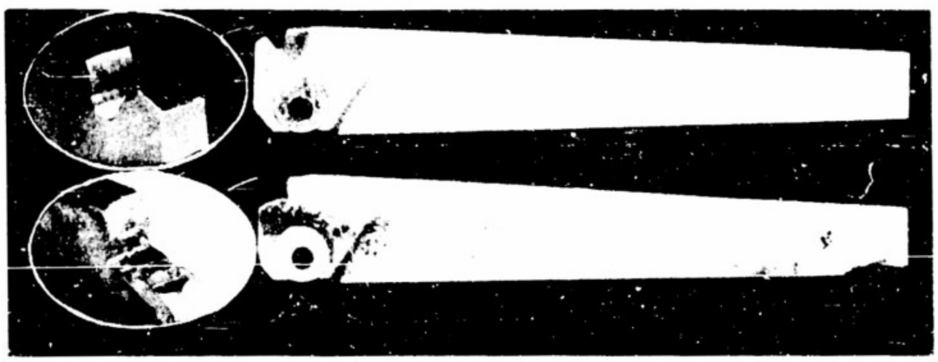


Fig. 6.
Failure Of Fin Gear Tooth.

Table V
Firing Record
Test Of Spin and Of Fin Opening
BAT 90 mm. Folding Fin Projectile

Date of Test *December 14, 1953* *Erie Ord Depot*

Purpose of Test *Test Spin & Fin Opening of 90mm Folding Fin Projectile*

|— 60' —|1— 51.08' —|2

Screen Distances

PROJECTILE
Model *BAT 90mm*
Type *Folding Fin*
Weight *11.50 lb (Nom)*
CG Location ——
Bourrelet Dia ——
Special Features *a Orifice dia .136 in, b Two "O" Ring Obturators on chamber, c Blunt nose modified T300 nose d Estimated Retardation Factor = 0.3 ft/s/ft*

TEST GUN
Model *BAT 90mm*
Type *90mm Recoilless Rifle*
Serial No *1*
Chamber *8 49822*
Bushing (Vent) *22-C-226-P*
Tube *8444-11*
Sighting Equipment *M17 Adapted Telescope*
Mount
Type *Pendulum*
Constant *2.83 lb sec/in.*

MISCELLANEOUS DATA
Range *Recovery Box*
Propellant
Type *M10 MP* Web *.040 in.* Weight *7 lb. 10 oz.*
Lot No *PRE 9932*
Primer *M57*
Shell Case *T53E1 modif.*
Liner *T52 modified*
Temperatures
Magazine
Max *72°F* Min *70°F* Present *70°F*
Loading Room *60°F* Ambient *46°F*

Round No	Proj No.	Proj Weight (lb)	Powder Charge (lb-oz)	Wind Vel & Dir	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Elev (mils)	Azimuth (mils)	Position of Hit Vert	Position of Hit Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Recoil (in)	Observations
6546	X1710	11.52	7-10	—	13,000 / 11,900	2070	2096								Piston stop knurl turned down to 1.563 −.004 in.
6547	X1709	11.50	7-10	—	12,000 / 12,100	2071	2097								Piston stop knurl unmodified - 1.568 in.

Description of Recovered Components

Notes 1 Projectile X1710 (chamber no 49, tail assy no 1) - Fins twisted; lug on one fin sheared off; ring completely sheared
2 Projectile X1709 (chamber no 50, tail assy no 17) - Fins twisted; ring sheared, one fin broken

Card	Round 6546 Fin Spread (in)			Yaw	Card	Round 6547 Fin Spread (in.)			Yaw
1	10 7/8	11 5/8	10 7/8	3 1/2	1	9 1/2	9 1/2	9 7/8	3 1/8
2	10 7/8	[illegible] 7/8	10 3/4	—	2	9 1/2	—	—	3 5/8
3	[illegible]	10 1/4	10 1/2	4 1/4	3	9 1/4	9 1/4	9 3/4	3 5/8
4	10 1/2	10 1/4	10 1/4	3 3/4	4	9 1/4	9 1/4	9 1/2	3 5/8
5	9 1/2	—	—	3 1/4	5	9 3/8	—	9 3/4	3 5/8

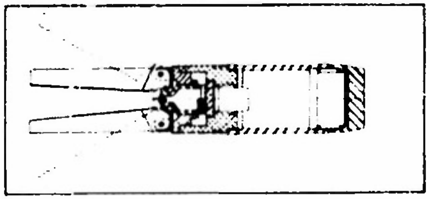
Muzzle |— 29.58' —|— 16.0' —|— 24.33' —|— 51.0' —|— 66.83' —|
1 2 3 4 5

Yaw Card Distances

Yaw Card Measurements

Card No	Distance (ft) from Muzzle	Rotation (degrees)* Rd 6546	Rotation (degrees)* Rd 6547
1	29.6	197.5	337
2	35.6	199	339
3	59.9	215	355.5
4	110.9	277	414
5	177.7	394.5	533.5

* Angle in each case is measured clockwise from a horizontal reference line starting with Card No 1. Multiples of 360° added as required.



Proof Director *E Huffman*
Observers *R Finucan*
Signed *O Miller*

Table VI
Firing Record
Test Of Spin and Of Fin Opening
BAT 90 mm. Folding Fin Projectile

Date of Test 26 January 1954

Purpose of Test To Test Fin Opening & Spin Of BAT 90mm Folding Fin Projectile
Program # 80

PROJECTILE

Screen Distances 60'6" 50'10"

Model 90mm BAT
Type Folding Fin Type ; Blunt Nose
Weight 12 lb (Nom)
CG Location
Yaw Card Distances: Muzzle 32'4" 18' 50'10" 38' 28'2"
Bourrelet Dia 3.537 -.002 in
Special Features (a) .113 in orifice (b) Two 'O' Rings (Parker #5430-14) on chamber (c) .016 Housing - Stop Interference, (d) 40 minute cant angle on fins

TEST GUN

Model BAT : 90mm
Type Recoil Test
Serial No 1
Chamber B-4982-2
Bushing (Vent) 82-G-226-P ; O' Flow Ring
Tube Smooth Bore
Sighting Equipment M17 Elbow Telescope
Mount
Type Ballistic Pendulum   Electric Firing Head
Serial
Pendulum Constant = 283 lb.sec/in

MISCELLANEOUS DATA

Range Recovery Box
Propellant
Type MP M5 Web .040 in Weight Varied
Lot No RAD 16415
Primer M57
Shell Case T53E1 (Mod)
Liner T-6 (Mod)
Temperatures (Deg F)
Magazine
Max 73° Min 71° Present 72°
Loading Room 68° Ambient 39°

Round No	Proj No	Proj Weight (lb.)	Powder Charge (lb - oz)	Wind Vel. & Dir	Chamber Pressure (M3 Inc) (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Body (in) Yaw	Fin Opening (in) Card 1	Card 2	Card 3	Card 4	Card 5	Recoil (in)	Observations
6651	28	11.95	6 - 13		14,200 14,200	—	—	3½ x 3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	
6652	29	12.13	6 - 13		14,400 14,300	—	—	3[illegible] x 3[illegible]	[illegible]	9 x 9 x 9	[illegible]	9 x 9 x 9	[illegible]	4½	
6653	31	12.14	6 - 9		12,800 13,000	—	—	3[illegible] x 3[illegible]	9[illegible] x - x -	[illegible]	[illegible] x -	[illegible] x -	[illegible]	3½	
6654	27	11.95	6 - 8		11,800 11,800	—	—	3[illegible] x 3[illegible]	[illegible]	[illegible]	[illegible] x -	[illegible]	9 x 9 x 9	5	
6655	30	12.14	*		14,400 13,500	—	—	3[illegible] x 3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	

* On the loading of Round 6655 it was requested that 5 oz be taken from the case, but pressure and fin opening indicate that this may not have been done. The program director was present at initial loading.

** The yaw measurements given are recorded on the chart below. They are the smallest and largest measurements given on five (5) cards.

Recoil Unbalance + 14.15 lb sec

Round	YAW Card 1	Card 2	Card 3	Card 4	Card 5
6651	3½ x 3[illegible]	3[illegible] x 3½	3½ x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]
6652	3½ x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3½
6653	3[illegible] x —	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]
6654	3[illegible] x 3½	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]
6655	3½ x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]	3[illegible] x 3[illegible]

Center of Impact
Probable Error — Vertical
Probable Error — Horizontal

Proof Director E. Huffman
Observers O. Miller
Signed M. Manoesky

Table VII
Firing Record
Accuracy Of BAT 90 mm. Projectile
2,000-yard Range

Date of Test January 25, 1956
[illegible]

Purpose of Test BAT 90mm Accuracy at 2000 yds

PROJECTILE
Model BAT 90mm
Type Folding Fin
Weight [illegible] Nominal
CG Location ——
Bourrelet Dia 3.537 $^{+.002}_{-}$ in
Special Features Orifice Dia .13 in
Nominal housing stop
interference .016 in

← 52.08 → 41.00 →
1 2
Screen Distances

Aiming Point Top L H corner of target
Azimuth [illegible] mils left of target center
Elevation Zero + 4.5 mils to target top
Impact points measured from target
center. Target top to target center
13.67 ft (2.27 mils).

TEST GUN
Model BAT 90mm
Type 90mm Recoilless Rifle
Serial No 1
Chamber [illegible]
Bushing (Vent) 0° Flow Ring
Tube [illegible]-11 (Smooth Bore)
Sighting Equipment [illegible] Direct Sight
Mount
Type T152E7
Serial 1

MISCELLANEOUS DATA
Range 2009 yd Target
Propellant
Type M5 MP Web .040 in Weight 6 lb 14 oz
Lot No RAD 16415
Primer M57
Shell Case T53E1 modif
Liner T6 modif
Temperatures
Magazine
Max 73°F Min 71°F Present 72°F
Loading Room 69°F Ambient 39°F

Round No	Time of Flight (sec)	Proj Weight (lb)	Proj No	Wind Vel mph	Wind Dir degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Total Elev (mils)	Fin Opening*** (in)	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Yaw (in)		Cut** O Ring	Observations
6736	—	11.95	32	5	170	[illegible] 4,200	—	—	33	9×9×9	-7	+56	Not measurable		Yes	Terminal Velocity 1151 fps
6737	—	11.92	33	4	80	13,[illegible] 13,[illegible]	[illegible]	2213	33	—	—	—	—		No	Missed Target
6738	—	11.92	32	5	170	4,100 14,300	2203	2215	33	—	—	—	Not measurable		Yes	Terminal velocity 1591 fps
6739	—	11.94	9	5	170	14,600 14,300	2217	2230	33	—	—	—	—		Yes	Missed Target
6740	—	11.92	33	8	175	13,900 13,300	2207	2220	33	—	—	—	—		Yes	Missed Target
6741	—	11.92	35	4	150	5,200 4,800	2210	2223	32	—	—	—	—		Yes	Hit short of target
6742	—	11.93	30	4	150	14,100 13,500	2170	2183	33	—	—	—	—		No	Missed Target
6743	—	11.92	38	6	160	13,700 13,900	2209	2222	33	9×8⅞×8⅞	+31	-67	3⅞×3⅞		Yes	
6744	—	11.92	37	5	160	13,800 14,300	2200	2213	34	8½×9×8½	-1	-80	Not measurable		No	
6745	—	11.92	39	9	150	13,400 13,100	2172	2185	34	9×8¾×8¾	-87	-48	3½×3½		No	
6746	3.82399	11.95	23	5	145	14,800 14,500	2220	2233	34	8¼×8¼×—	+55	-72	—		Yes	
6747	3.85613	11.95	16	5	150	13,800 13,400	2193	2206	34	9×9×9	-29	-8	Not measurable		* Unknown	
6748	3.89514	11.95	1	5	145	12,900 13,000	2188	2201	34	9×9×9	-83½	-34½	3½×3½		* Unknown	
6749	—	11.91	35	4	110	13,800 12,200	2152	2165	34	—	—	—	—		* Unknown	Missed Target
6750	—	11.96	21	4	110	13,400 12,400	2177	2190	34	—	—	—	—		* Unknown	Missed Target
6751	3.86183	11.91	36	5	120	13,100 13,000	2166	2179	34	8¼×8¼×8¼	-69	-6	3½×3¼		No	

*Program Director not present at loading
Cocking handle of Spotting Rifle prevents proper seating of Gunners Quadrant on Trunnion Pads
Three hits short of Target, measured at 64' 9", 81', and 103'
Two hits behind Target at 22'6" and 31'4" (Bottom of Target to ground - 3 ft)
** O ring was cut by shell case mouth in assembling some of the rounds.
*** Nominal fin opening 9.2 in.

Proof Director E. Huffman
Observers Drs. Miller & Lucas
W. Lowe, L. Sweeby, O. Miller
R. Finucan

Signed M. Manofsky

Spin Measurements

Spin measurements of BAT 90mm projectiles were included in the firing programs of Tables V and VI. Values of angular rotation versus distance were obtained from yaw card imprints for two rounds listed in Table V. The values were plotted and the points were connected by smooth curves. The slopes of the plotted curves were measured at intervals of twenty feet and values of spin in revolutions per second were calculated. Table VIII lists these values and plots of spin versus distance are shown in Fig. 7. Measurements at points further down range are required to establish the peak spin rate.

Table VIII
Spin Versus Distance Down Range
BAT 90 mm. Projectile; Orifice Diameter, .136 in.
Fired From Smooth Bore Tube

Distance (feet)	Round 6546			Round 6547		
	$\frac{\Delta\phi}{\Delta Z}$ (°/ft)	u (fps)	$\frac{\Delta\phi}{\Delta Z}$ (rps)	$\frac{\Delta\phi}{\Delta Z}$ (°/ft)	u (fps)	$\frac{\Delta\phi}{\Delta Z}$ (rps)
40	.625	2084	3.62	.55	2085	3.19
60	.95	2078	5.48	.85	2079	4.91
80	1.175	2072	6.76	1.10	2073	6.33
100	1.40	2066	8.03	1.375	2067	7.89
120	1.625	2060	9.30	1.625	2061	9.30
140	1.8	2054	10.27	1.8	2055	10.28
160	1.85	2048	10.52	1.875	2049	10.67
180	1.875	2042	10.64	1.925	2043	10.92

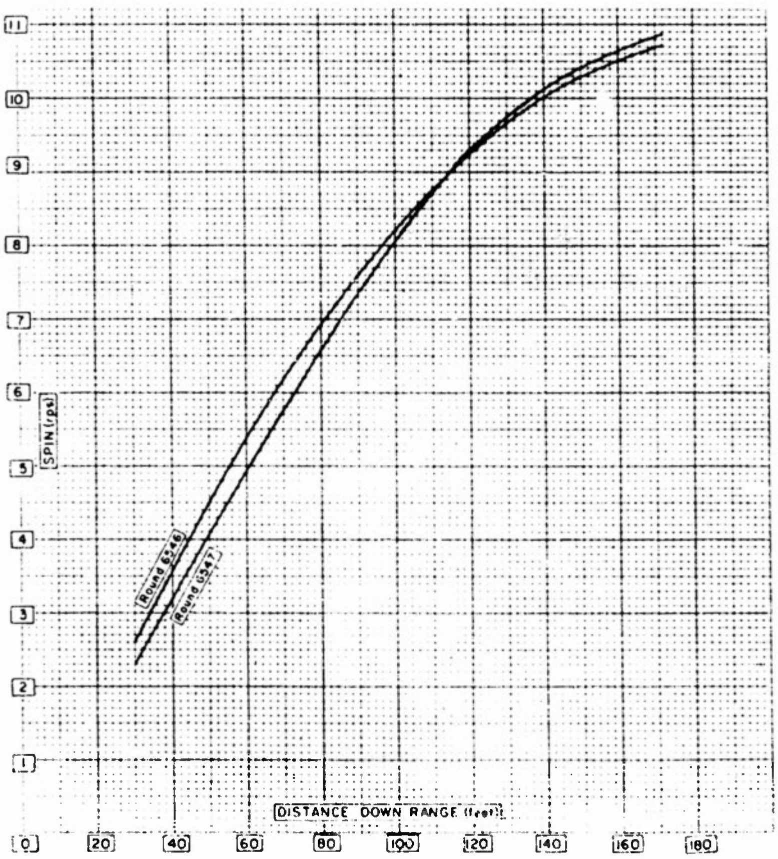


Fig. 7. Spin Versus Distance Down Range.
BAT 90 mm. Folding Fin Projectile.

Values of angular rotation and distance for another five projectiles are given in Table IX. Since no projectile velocities were recorded on this program, it was not possible to compute projectile spin in revolutions per second. However, projectile spin in degrees per foot can be determined from plots of angular rotation versus distance. Projectile spins (deg/ft) versus distance down range are listed in Table X and plots of these values are shown in Fig. 8.

Table IX
Angular Rotation Versus Distance Down Range
BAT 90 mm. Projectile; Orifice Diameter, .113 in.
Fired From Smooth Bore Tube

Card No.	Distance (feet)	Rotation (degrees)[a]				
		Proj. 27	Proj. 28	Proj. 29	Proj. 30	Proj. 31
1	32.3	195	177	282	10	245
2	60.3	207	193	292.5	23.5	259
3	111.2	256	254	334	71	309.5
4	149.2	307	324	380	115.5	367
5	178.4	353	388	424	175	421

a. Angle in each case is measured clockwise from a horizontal reference line starting with Card 1. Multiples of 360° have been added as required.

Table X
Spin (Deg./Ft.) Versus Distance Down Range
BAT 90 mm. Projectile
Fired From Smooth Bore Tube

Distance (feet)	Spin (deg./ft.) Projectile Number 27	28	29	30	31
40	.38	.55	.30	.40	.43
60	.65	.83	.53	.58	.68
80	.88	1.13	.75	.80	.93
100	1.08	1.38	.95	1.00	1.15
120	1.28	1.68	1.15	1.30	1.4
140	1.45	1.98	1.33	1.55	1.6
160	1.55	2.15	1.48	1.80	1.8
180	1.625	2.43	1.65	1.95	1.98

It should be noted that the designed cant on the BAT 90mm fin is 24.6 minutes, while the modified fins which were used in the above groups of projectiles had a cant angle of 40 minutes. Fins with the proper cant will soon be available for test, and it is expected that they will provide a lower level of spin rate.

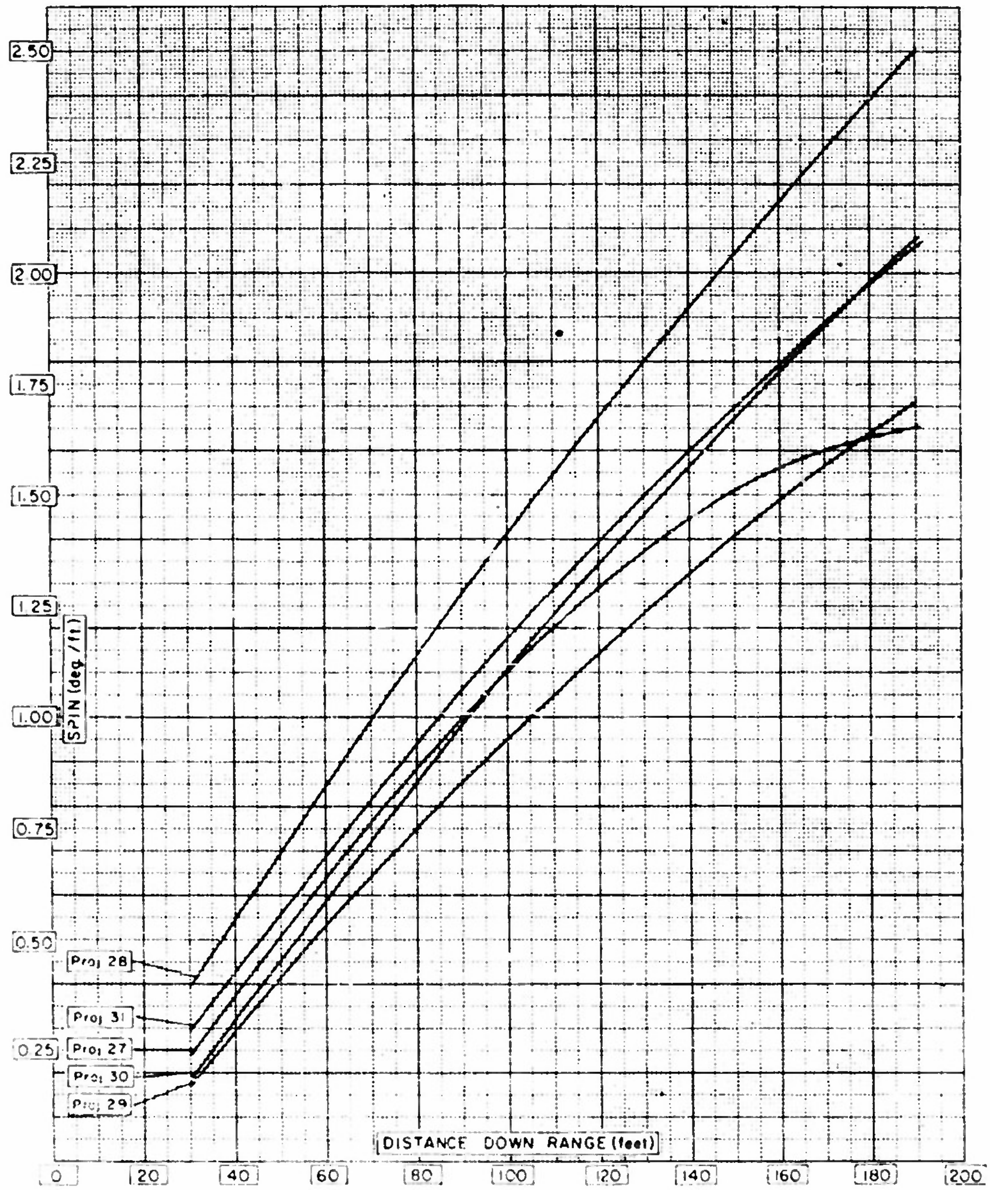


Fig. 8. Spin Versus Distance Down Range.
BAT 90 mm. Folding Fin Projectile.

Projectiles With Large Diameter Housings

Fin marks in the muzzle of the gun have been observed in previous T119E11 firing programs. It is felt that these fin markings indicated that the undercut tail of the T119E11 projectile permitted the projectile to shift relative to the muzzle as it emerged from the gun. It was therefore, decided to test a group of projectiles with housing diameter large enough to serve, in effect, as a third bourrelet and perhaps minimize the shift of the projectile.

Twenty T119E11X projectiles were assembled with a housing O.D. of $4.118^{-.005}$ in. instead of the standard $3.938^{-.005}$ in. O.D. The modification is shown in Fig. 9.

Five of these projectiles were fitted with blunt noses and were fired into a sawdust filled recovery box. The range data are presented in Table XI. The remaining fifteen were fired alternately with ten standard T119E11 rounds at an 18 ft. by 18 ft. target at 995 yards. The range data are shown in Table XII.

In the accuracy test, both groups of projectiles flew well and had normal fin openings. Probable errors of dispersion for the experimental group were ±.44 mil vertical and ±.50 mil horizontal while the standard group gave probable errors of dispersion of ±.37 mil vertical and ±.53 mil horizontal. The probable error comparison is only indicative because of the small size of the samples and because sighting difficulties were experienced in the course of firing which necessitated a sub-grouping of both groups for probable error calculations.

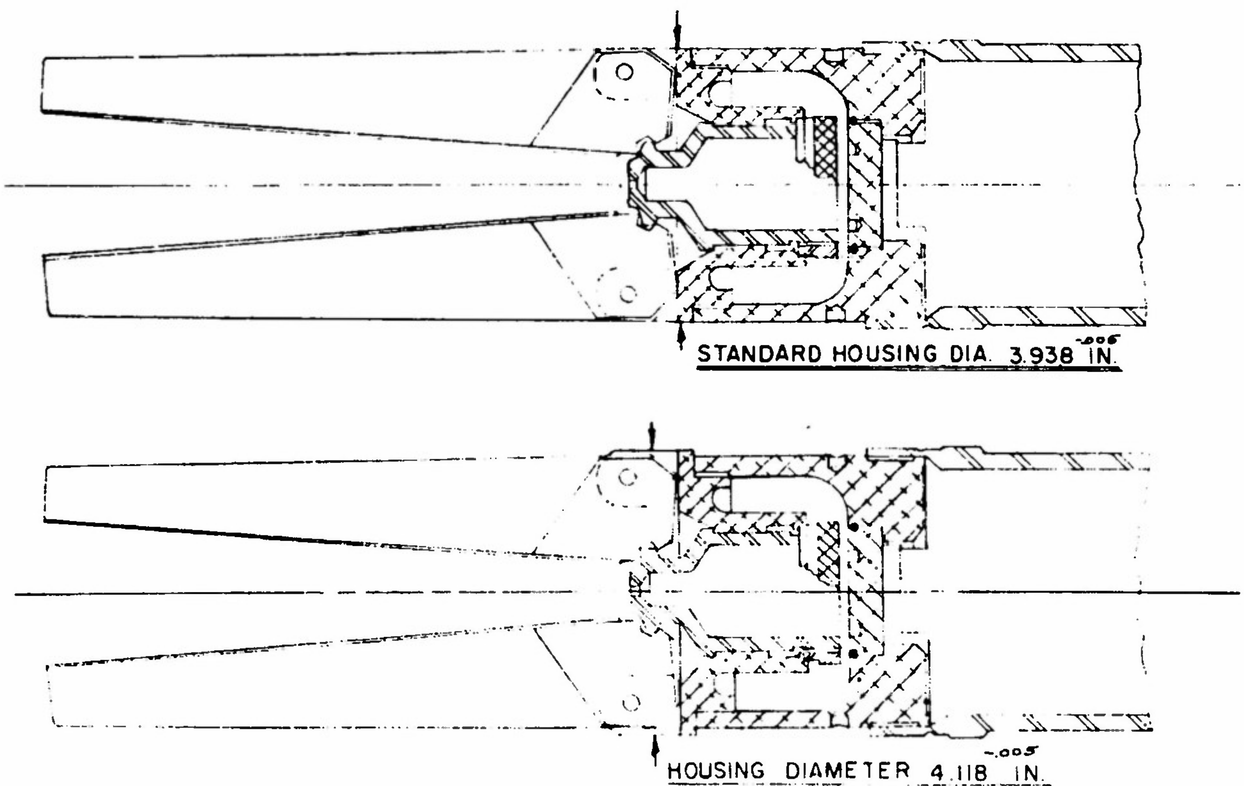


Fig. 9. T119E11X Projectile Modification.
Housing O.D. 4.118 in. Instead Of 3.938 in.

Bad erosion was noted on the housings of the recovered projectiles. A photograph of a typical recovered tail assembly is shown in Fig. 10. Such erosion has never been noticed before on the standard T119E11 projectile. It is believed that the flow of powder gases through the constricted area between the enlarged housing and the lands of the gun was responsible for the erosion.

This modification will not be tested further.

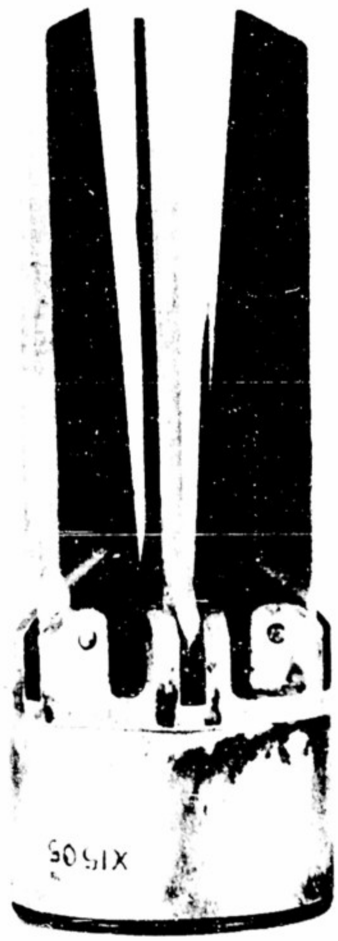


Fig. 10. Recovered T119E11X Projectile Tail Assembly. Showing Erosion On Large Diameter Housing

Table XI
Range Data
To Test Launching Effect Of Large Diameter Housing
Housing Diameter Of 4.118 in.

Date of Test December 7, 1953 Erie Ord Depot

Purpose of Test Effect of Launching on T119E11XB Projectiles

PROJECTILE
- Model T119
- Type E11XB (Blunt nose)
- Weight 17.5 lb (Nom)
- CG Location —
- Bourrelet Dia 4.132 - .002 in
- Special Features 4.118 in Hsg, 0.030 in. Shear ring; 1.822 in turned-down knurled stop

TEST GUN
- Model T170E1/M40
- Type 106 mm. Recoilless Rifle
- Serial No 61
- Chamber F23
- Bushing (Vent) F26 (15°)
- Tube 22-C-511-3 (1 in 20 Twist)
- Sighting Equipment M17 Elbow Scope
- Mount
  - Type Pendulum
  - Constant 2.23 lb sec/ft.

MISCELLANEOUS DATA
- Range Recovery Box
- Propellant
  - Type M10 MP Web .035 in. Weight 7 lb. 12 oz
  - Lot No PA 30259
- Primer M57
- Shell Case T53E1
- Liner DRC 545, 36 oz/yd²
- Temperatures
  - Magazine Max 72°F Min 70°F Present 70°F
  - Loading Room 64°F Ambient 48°F

Round No *	Proj No.	Proj Weight (lb.)	Powder Charge (lb-oz)	Wind Vel. & Dir.	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Elev (mils)	Azimuth (mils)	Yaw Cord Measurements (inches) Cord 1	Cord 2	Cord 3	Cord 4	Recoil (in)	Observations
6480	X1509	17.50	7 - 12		9200	—	—			4 1/8 - 4 1/8	4 1/8 - 4 1/8	4 1/8 - 4 1/8	4 1/16 - 4 1/8	3/4 F	Top three rows of holes taped to prevent
					9500										propellant loss. Fin housing loose on recovery
															Recovered projectile had two bent fins
6481	X1505	17.50	7 - 12		8900	—	—			4 1/8 - 4 3/16	4 1/8 - 4 1/8	4 1/8 - 4 1/8	4 1/8 - 4 3/16	1 1/4 R	Top three rows of shell case holes taped.
					8900										Recovered projectile had one bent fin.
6482	X1506	17.50	7 - 12		8800	1600	1635			4 1/8 - 4 3/16	4 1/8 - 4 5/16	4 1/8 - 4 5/16	4 1/8 - 4 3/16	3/4 R	Shell case holes taped as above.
					9100										Recovered projectile had two bent fins
6483	X1508	17.50	7 - 12		8700	1549	1584			4 1/8 - 4 1/8	4 1/8 - 4 5/16	4 1/8 - 4 1/8	4 1/8 - 4 1/4	2 R	Shell case holes taped as above. No projectile
					9100										on developed film. Recovered proj. had three bent fins
6484	X1507	17.50	7 - 12		8800	—	—			4 1/8 - 4 1/4	4 1/8 - 4 1/8	4 1/8 - 4 1/8	4 1/8 - 4 3/16	3/8 F	Shell case holes taped as above. Recovered
					8600										projectile had one broken & three bent fins.

* Fin assembly & rear of chamber housing greased on all rounds.

Fastax pictures taken of Rounds 6482 & 6483, camera jammed on Round 6484.

Gun — 30' 2 1/2" — 1 — 30' 10" — 2 — 51' 3" — 3 — 66' 10 1/2" — 4 — Recovery Box

Yaw Cord Distances

— 61' 0 1/2" — 1 — 51' 3" — 2

Velocity Screen Distances

Proof Director E Huffman Signed —

CONFIDENTIAL

Table XII
Range Data
Accuracy Of T119E11X Projectile With Large Diameter Housing

Date of Test January 7, 1954
Erie Ord Depot

Purpose of Test Accuracy of T119E11X with 4.118in O.D. Housing

PROJECTILE
Model T119E11 & E11X
Type Std & Experim Proj
Weight 17.5 lb (Nom)
C.G. Location ——
Bourrelet Dia 4.132 -.002 in
Special Features 4.118in O.D. on Housing, 0.030in Shear ring; 1.822in turned down knurled stops

TEST GUN
Model T170E1 ½ Spotting Rifle Mount
Type 106mm Recoilless Rifle
Serial No 61
Chamber 61
Bushing (Vent) F26
Tube 22-C-511-5 (1/20 Twist)
Sighting Equipment Bore Sight, M17 Elbow Scope
Gunners Quadrant
Mount
Type Rigid
Serial ——
Solenoid fired mechanically

MISCELLANEOUS DATA
Range 998 yd
Propellant
Type M10 MP Web .035in. Weight 7lb 12oz
Lot No. PA 30259
Primer M57
Shell Case T53E1
Liner DRC 545 (30 oz/yd²)
Temperatures
Magazine
Max 72°F Min 70°F Present 72°F
Loading Room 72°F Ambient 31°F

Round No	Proj No.	Proj Weight (lb.)	Type of Proj.	Wind Vel mph	Wind Dir degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils Vert.	Corrected Position of Hit — mils Horiz	Recoil (in)	Observations
6620	X1036	17.52	Std	1	215	8300 8800	1628	1643	0	5	22.5	-2.289	-1.675	-0.489	-1.675		Warm up round. Good flight. Omitted from P.E. calculations
6621	X1517	17.50	Exp	1	215	—	1600	1616	0	5	22.5	-2.945	-2.206	-1.145	-2.206		Good flight. Low richochet into target knocking off lower 2x4
6622	X1072	17.53	Std	1	215	8600 8700	1618	1634	-1	5	24.3	-0.726	-1.368	-0.726	-0.368		Good flight
6623	X1520	17.54	Exp	1	215	8800 9300	1616	1632	-1	5	24.3	-1.228	-0.893	-1.228	+0.107		
6624	X1082	17.51	Std	1	215	7107 8600	1604	1620	-1	5	24.3	-1.661	-0.517	-1.661	+0.483		
6625	X1521	17.54	Exp	1	215	—	1616	1632	-1	5	24.3	-0.866	-2.373	-0.866	-1.373		
6626	X1057	17.50	Std	1	205	8500 9600	1633	1649	-1	5	24.3	-0.363	-1.591	-0.363	-0.591		
6627	X1513	17.53	Exp	1	205	—	1602	1618	-1	5	24.3	-2.722	-2.890	-2.722	-1.890		
6628	X1004	17.50	Std	1	205	8900 9100	1625	1641	-1	5	24.3	-1.452	-1.326	-1.452	-0.326		
6629	X1512	17.53	Exp	1	200	8400 8600	1606	1622	-1	5	24.3	-0.866	-1.173	-0.866	-0.173		
6630	X1116	17.50	Std	1	195	8900 8900	1604	1620	-1	5	24.3	-1.703	-2.164	-1.703	-1.164		Recovered projectile
6631	X1524	17.53	Exp	2	190	—	1601	1617	-1	5	24.3	-2.122	-0.768	-2.122	+0.232		

page 1 of 2 continued on page 20

Proof Director E. Huffman
Observers L. Sweebly
R. Finucci

Signed W. McMillan

Table XII (Cont'd)

Page 2 of 2

Date of Test January 7, 1954
Erie Ord Depot

Purpose of Test Accuracy of T119E11X with 4.118in OD Housing

PROJECTILE

Model T119E11 & T119E11X

Type 2nd 2-Barrier Proj

Weight 17.5 lb (nominal)

CG Location —

Bourrelet Dia 4.112 / .002

Special Features 4.118in O.D. in housing, 0.030in shear ring, 1.822in turned down knurled stem

TEST GUN

Model T170E1 w/ Spotting Rifle Mount

Type 106mm Recoilless Rifle

Serial No 61

Chamber 61

Bushing (Vent) F26

Tube 22 cal (1/20 Twist)

Sighting Equipment Bore Sight, M17 Elbow Scope, Gunners Quadrant

Mount
Type Rigid
Serial —

Solenoid fired mechanically

MISCELLANEOUS DATA

Range 998yd Target

Propellant
Type M10 MP Web .035in. Weight 7lb 12oz
Lot No PA 30257

Primer M57

Shell Case T53E1

Liner DRC 545 (30oz/yd²)

Temperatures
Magazine
Max 72°F Min 70°F Present 72°F
Loading Room 72°F Ambient 32°F

Round No	Proj No	Proj Weight (lb)	Type of Proj	Wind Vel (mph)	Wind Dir (degrees)	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit – mils Vert	Corrected Position of Hit – mils Horiz	Recoil (in)	Observations
6632	#1587	[illegible]	Std	2	185	8100 9000	1610	1626	-1	5	243	-0.530	-2.387	-0.530	-1.387		
6633	#1519	17.5[illegible]	Exp	3	185	—	1609	1625	[illegible]	5	243	-0.642	-1.173	-0.642	-0.173		
6634	[illegible]	17.54	Std	7	180	8400 9200	1624	1640	-1	5	243	-1.000	-2.876	-1.000	-.876		Projectile knocked panel down
6635	#1522	17.53	Exp	2	180	6300 7200	1606	1622	-1	5	243	Missed - Panel out of place					Shim plate added.(a) Gun relaid
6636	#1109	17.52	Std	5	260	8400 8900	1624	1640	0	5	245	+1.201	+0.098	+1.201	+0.098		
6637	#1518	17.50	Exp	6	240	7300 8500	1622	1638	0	5	245	+0.849	+0.349	+0.389	+0.349		
6638	#1169	17.50	Std	8	265	8300 8800	1604	1620	0	5	245	+0.363	+0.670	+0.363	+0.670		
6639	#1514	17.53	Exp	6	260	8800 9100	1614	1630	0	5	245	-1.033	-1.312	-1.033	-1.312		Recovered projectile
6640	#1515	17.52	Exp	5	260	8100 8300	1603	1619	0	5	245	-0.642	-0.070	-0.642	-0.070		
6641	#1516	17.54	Exp	6	260	8400 9600	1621	1637	0	5	245	+0.056	0.056	+0.056	0.056		Recovered projectile
6642	#1511	17.54	Exp	7	255	8600 9100	1606	1622	0	5	245	-0.572	-0.307	0.572	0.307		
6643	#1523	17.53	Exp	5	250	8600 9100	1617	1633	0	5	245	0.168	1.019	-0.168	-1.019		
6644	#1510	17.54	Exp	8	260	8100 8600	1588	[illegible]	0	5	245	0.824	+0.503	0.824	+0.503		

Gun — 55' 4" — 1 — 48' 2" — 2 — 40' 4" — 3 — 39' 8½" — 4

Screen Distances

Line of fire - 28° measured clockwise from magnetic North

(a) Difficulty encountered in getting readings of gunners quadrant alike without moving gun. A slight movement of Brinell bar caused the change.

Loaded as complete rounds.

Table of Probable Errors

Projectile Type	No. of Rounds	PE_V	PE_H
T119E11	7 (a)	37 mil	53 mil
T119E11X	13 (b)	.44 mil (c)	.50 mil (c)

(a) Ten T119E11 rounds fired. Round 6630 was warm up round and not included in probable error calculations. Rounds 6626 & 6628 were fired after gun was relaid and were also not included in probable error calculations.

(b) Fifteen T119E11X rounds were fired. Round 6621 hit low due to low elevation. Round 6635 went through hole in target and no measurement was possible. These rounds were not included in probable error calculations.

(c) Combined probable errors calculated from two centers of impact by the following equation

$$PE_c = .6745\sqrt{\frac{\Sigma D_1^2 + \Sigma D_2^2}{(n_1 + n_2) - 1}} \quad \text{where } D = (X_i - \bar{X})^2$$

and n = number of rounds in each group

Proof Director E. Huffman

Observers L. Swoebly, R. Finucan

Signed W. McMillan

Test Of Oversize Hinge Pin Holes

A group of T119E11 projectiles with oversize hinge pin holes was prepared to test the effect of the oversize hinge pin holes upon the accuracy.

Ten housings were inspected and assembled in projectiles. The inspection data are shown below:

The projectiles were fired alternately with ten standard T119E11 projectiles at an 18 ft. by 18 ft. target at 995 yards. The range data are presented in Table XIII. Probable errors of dispersion for the experimental group were ±.49 mil vertical and ±.44 mil horizontal. For the standard group the probable errors of dispersion were ±.41 mil vertical and ±.53 mil horizontal. Only the last eight rounds of each group were used in the probable error calculations because it became necessary to re-lay the T170E1 gun in the rigid mount during the firing.

Projectile Number	Hinge Pin Hole Diameter = .2508$^{+.0005}$ in. Measured Hinge Pin Hole Diameters					
X1619	.256	.256	.2565	.2525	.252	.2525
X1611	.2515	.2533	.254	.251	.2563	.2553
X1605	.2555	.258	.262	.259	.260	.259
X1644	.257	.259	.256	.255	.257	.261
X1629	.254	.254	.253	.255	.254	.255
X1626	.254	.258	.254	.2575	.2545	.255
X1608	.255	.255	.256	.2515	.2515	.257
X1662	.252	.255	.257	.2555	.2593	.2593
X1625	.254	.256	.258	.257	.255	.256
X1617	.260	.2567	.2555	.257	.2645	.264

Future Program

1. An accuracy firing is being planned for three groups of projectiles. One group has short bodies, short ogives, rounded nose caps and T119E11 tail assemblies. The second group has short bodies, long ogives, rounded nose caps and T119E11 tail assemblies. The third group has short bodies but otherwise are standard T119 E11 shell. These projectiles will be tested to determine the effect of variable body and ogive lengths on flight performance.

2. Twenty T119E11 projectiles have been assembled with tracer capsules in the tail assembly. The rounds will be fired to determine the visibility and length of trace.

3. Ten T119E11X projectiles with gilding metal obturating bands have been fired for accuracy from a T137E3 gun with a smooth bore tube. The results will be reported in February.

4. Projectiles with 6.92 in. long fins and double "O" ring obturators will be fired for accuracy, and for spin determination in the vicinity of the muzzle and at 1000 yards.

5. A design incorporating a tapered piston stop, which does not require knurling, has been tested in conjunction with tests of maximum and minimum interference in the fin opening mechanism of the T119E11 projectile. The data have not been reduced yet.

Table XIII
Range Data
Accuracy Of T119E11X Projectile
To Test Effect Of Oversize Hinge Pin Holes

Date of Test January 8, 1954 / January 11, 1954 / Erie Ord Depot

Purpose of Test Accuracy of T119E11X with Oversize Pin Holes in 24ST4 Housings

PROJECTILE

Model T119

Type E11 & E11X

Weight 17.5 lb (Nom.)

C G Location ——

Bourrelet Dia 4.132 in

Special Features E11X with Oversized Pin Holes & 24ST Housing

E_{Gun} ⊢ 5533' ⊢ 4812' ⊣ 2

Velocity Screen Distances

TEST GUN

Model T170E1/M40

Type 106mm Recoilless Rifle

Serial No 61

Chamber F23

Bushing (Vent) F26

Tube 22-C-511-S

Sighting Equipment M62E4 & Gunners Quadrant

Mount

Type Rigid

Serial ——

Solenoid fired mechanically

MISCELLANEOUS DATA

Range 995 yd Target

Propellant

Type M10 MP Web .035 in Weight 7 lb 12 oz

Lot No PA 30259

Primer M57

Shell Case T53E1

Liner DRC 479-1

Temperatures

Magazine

Max 73°F Min 71°F Present 72°F

Loading Room —— Ambient 30°F

Round No	Proj No[1] & Type	Proj Weight (lb)	Retard Factor (fps/ft)	Wind Vel mph	Wind Dir degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils[2] Vert	Corrected Position of Hit — mils[2] Horiz	Normal Wind Compon (mph)	Fin Opening Dia (in)	Body Yaw (in)	
6649	X1602	17.07	—	14	120	8400 8800	1635	1650	0	•	29.3	—	—	—	—	—	Warm-up, 4 fin T119		Fired Jan 8
6650	X1616 S	17.52	—	9	110	7400 8200	1602	1617	0	-		Not measured		—	—	—	—	—	Fired Jan 8 High wind,
6659	X1607	—	.202	8	246	— 8400	1649	1664	0	56	29.1	—	—	—	—	—	Warm-up, 4 fin T119EX		Fired Jan 11, 1954
6659	X1706 S	17.54	.202	6	245	9100 9000	1616	1631	0	-		- 31	- 55	+0.735	-1.535	3.6	10 1/2	—	
6660	X1625 E	17.50	—	6	240	9000 9000	1621	1636	0			- 77	17	-0.548	0.474	3.2	10 1/2	4 5/16	
6661	X1091 S	17.52	—	6	240	8400	1625	1640	0			- 70	- 83	-0.353	2.316	3.2	10 1/2	4 3/16	
6662	X1629 E	17.50	.214	6	245	7800 8600	1612	1627	0			- 40	15	-0.484	0.419	3.6	—	—	
6663	X1127 S	17.50	.190	15	225	8800 9000	1620	1635	0	•	30.7	+ 25	+ 7	+0.698	+0.195	4.4	10 3/4	—	
6664	X1619 E	17.48	—	14	240	7800 8600	1613	1628	0			- 1	19	-0.028	-0.530	7.4	10 1/2	4 3/16	
6655	X1075 S	17.52	.190	7	250	8200 8600	1595	1610	0			21	32	-0.586	0.893	3.7	10 5/8	4 1/2	
6666	X1644 E	17.52	—	13	260	8700 9000	1622	1637	0			+ 17	23	+0.473	0.642	9.5	10 1/2	—	
6667	X1086 S	17.50	.190	11	250	8500 8900	1626	1641	0			- 3	- 51	-0.084	1.423	7.4	10 1/2	4 5/16	
6668	X1662 E	17.50	.190	15	255	9000 8800	1635	1650	0			+ 27	+ 22	+0.753	+0.614	11.0	10 1/2	4 1/4	
6669	X1650 S	17.50	.190	13	245	8400 8800	1612	1627	0			36	+ 32	-1.004	+0.893	7.8	—	—	
6670	X1608 E	17.52	—	10	235	8600 8700	1620	1635	0	•	30.7	+ 25	- 22	+0.698	0.614	4.5	10 1/2	4 3/16	
6671	X1623 S	17.54	—	7	260	8600 8800	1620	1635	0			+ 12	+ 22	+0.335	+0.614	5.5	10 1/2	4 1/4	
6672	X1611 E	17.51	.190	14	270	7200 8200	1610	1625	0			50	- 26	1.395	0.725	13.3	10 3/8	4 3/16	
6673	X1118 S	17.54	.190	15	255	8400 8200	1612	1627	0			+ 23	+ 4	+0.642	+0.112	11.0	10 1/2	—	
6674	X1626 E	17.48	.202	12	250	9200 9000	1632	1647	0	•	30.7	+ 10	24	+0.279	0.670	8.0	10 5/8	4 3/16	
6675	X1631 S	17.52	.190	8	235	7600 8400	1602	1617	0			- 18	17	-0.502	0.474	3.6	10 1/2	4 3/16	
6676	X1617 E	17.48	.190	9	250	7600 8400	1616	1631	0			+ 29 1/2	+ 20	+0.823	+0.558	6.0	10 3/4	4 1/4	
6677	X1630 S	17.54	.190	12	240	8600 8400	1620	1635	0			- 4	- 18	-0.112	0.502	7.2	10 1/2	4 1/4	
6678	X1605 E	17.48	—	10	250	8500 9400	1616	1631	0	•	30.7	+ 1	+ 24	+0.028	+0.670	6.7	10 1/2	4 1/4	
			Avg 0.195			Avg 8525	Avg.	1634											

Note: • in column denotes when elevation checked. 1. S = Standard proj, E = Experimental proj. 2. Corrected to 0 azm & 30.7 mils elevation

	T119E11-8rds.	T119E11X-8rds.
Probable Error — Vertical	0.41 mil	0.49 mil
Probable Error — Horizontal	0.53 mil	0.44 mil

Proof Director E. Huffman

Observers R. Finucan

Signed O. Miller

Effect Of Rotation Upon Standoff-Penetration Behavior

As the standoff distance is increased the penetration of a non-rotated shaped charge projectile rises to a maximum and then either remains essentially constant or decreases at a rate dependent upon the precision of the cone manufacturing, assembly and loading process. This behavior arises as a result of two facts: (1) that penetration is nearly proportional to jet length and (2) that a velocity gradient exists in jet and as the standoff distance increases the jet lengthens. With unlimited standoff the ultimate effective length attained by the jet is a function of the velocity gradient in the jet, the precision of the assembly and of the properties of the material of which the jet is composed. After the jet has reached as great a length as its ductility will allow, it breaks up into a number of particles which are then each subject to different aerodynamic forces and these particles spread or fan out at a rate dependent largely upon the symmetry of the assembly. When the projectile is rotated a new effect is noted:-a rotational velocity gradient is superimposed upon the linear velocity gradient. Under these conditions the length of the jet at the instant of incipient breakup is reduced and a shorter optimum standoff and lower maximum penetration is to be expected. Furthermore, once the jet has broken up into particles the rotational effect causes these particles to spread more rapidly and under these conditions penetration falls more rapidly with increased standoff than would otherwise be true. Thus, for any given shaped charge projectile assembly there is an optimum standoff and a maximum penetration and the values of both optimum standoff and maximum penetration decrease with increasing rotational velocity. The following experiment was undertaken to determine the relative magnitude of these effects.

A number of DRB398HW3 item 1 cones (.100 wall thickness, 3.5 inch effective diameter) were assembled in DRC376 test assemblies with No. 2 nose rings as shown in Fig. 11 and the penetration-standoff curves were determined at 0, 15 and 30 rps. The inspection data for the cones are shown in Table XIV and the penetration data are shown in Table XV and Fig. 12. The following tabulation shows the optimum standoff and maximum average penetrations observed in this test at each spin rate.

Spin Rate (rps)	Optimum Standoff (inches)	Max. Avg. Penetration (inches Mild Steel)
0	15	21.5
15	7.5	19.5
30	less than 7.5	approx. 14.5

It is recognized widely that the optimum standoff for most conical liners is greater than can be provided conveniently within the requirements for aerodynamically stable shell. An important conclusion to be derived from this experiment is that the above statement is not true when the shell must be rotated at a spin rate which might otherwise be considered acceptable. In such cases provision for increased ogive length or standoff will result in a reduced shaped charge effectiveness.

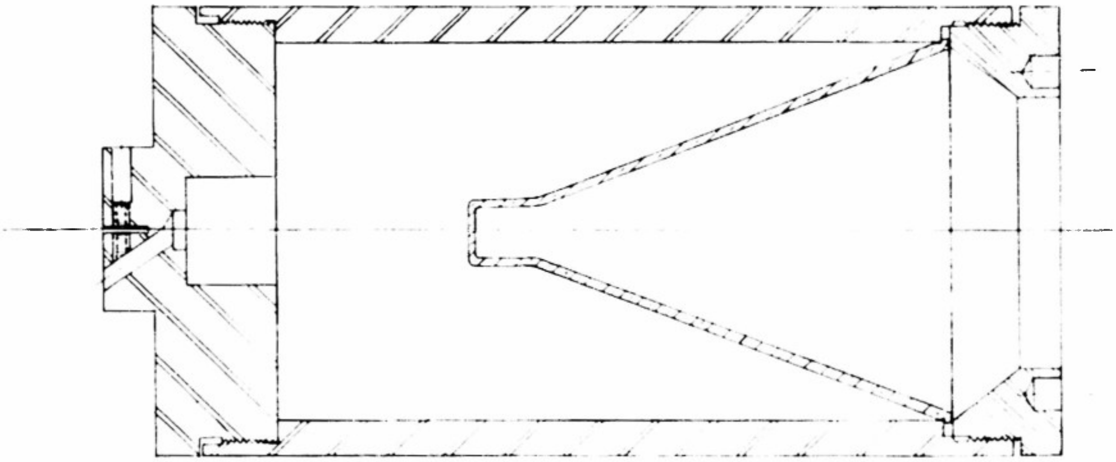


Fig. 11. Test Assembly.
DRC376 Assembly With No. 2 Nose Ring.

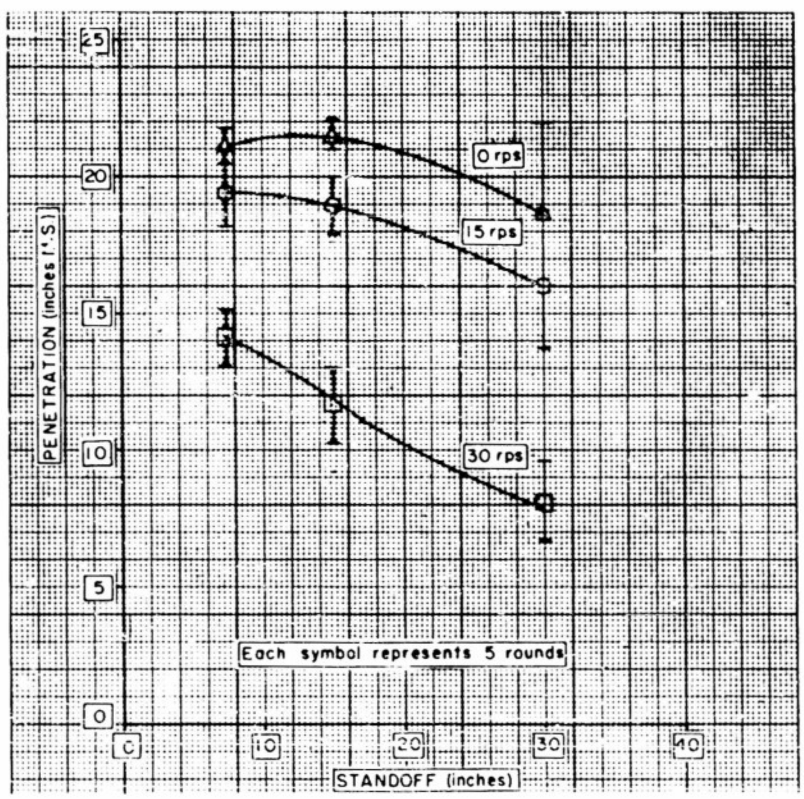


Fig. 12. Penetration Versus Standoff At Various Spin Rates.
DR8398HW3 Item 1 Drawn, Copper Cone.

Table XIV
Inspection Data
DRB398HW3 Item 1 Copper, Drawn Cones

Cone Number	Wall Thickness inches			Max Wall Thickness Variation-in.		Max. Wall Waviness inch		Concentricity — T. I. R. [1,2]		
	Max.	Min.	Avg.	Transverse	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB398 HW3 Item 1	.105	.100		.002	.006	.006	.006	.003	.003	.015 (Nominal)
A81	.111	.106	.1080	.003	.004	.001	.002	.008	< .001	.008
A82	.109	.106	.1068	.003	.002	.001	.002	.006	.012	.012
A83	.110	.104	.1065	.003	.005	.001	.002	.002	.004	.004
A84	.109	.105	.1062	.003	.004	.001	.002	.005	.008	.010
A85	.110	.103	.1060	.005	.004	.001	.002	.005	.008	.013
A86	.109	.104	.1065	.001	.004	.001	.002	.005	.004	.004
A87	.108	.104	.1058	.002	.003	.001	.002	.004	.003	.003
A88	.109	.103	.1062	.002	.006	.001	.002	.005	.004	.005
A89	.110	.105	.1065	.002	.005	.001	.002	.005	.009	.002
A90	.110	.105	.1061	.001	.005	.001	.002	.002	.006	.008
A91	.106	.101	.1034	.002	.005	.001	.002	.006	.010	.005
A92	.107	.103	.1050	.002	.002	.002	.002	.002	.008	.015
A93	.110	.106	.1072	.004	.003	.001	.002	.004	.006	.008
A94	.106	.103	.1046	.001	.003	.002	.002	.004	.006	.005
A95	.109	.103	.1059	.004	.004	.002	.002	.004	.006	.002
A96	.108	.102	.1055	.003	.006	.002	.002	.001	.004	.007
A97	.109	.102	.1049	.004	.007	.002	.002	.004	.004	.013
A98	.106	.101	.1039	.003	.005	.002	.002	.003	.005	.007
A99	.107	.103	.1051	.002	.004	.002	.002	.002	.005	.007
A100	.109	.101	.1049	.002	.007	.002	.002	.004	.004	.012
A101	.105	.101	.1031	.004	.003	.002	.002	.004	.002	.003
A102	.109	.102	.1054	.001	.007	.002	.002	.006	.004	.004
A103	.108	.102	.1049	.002	.006	.002	.002	.004	.004	.006
A104	.108	.101	.1048	.002	.005	.002	.002	.004	.008	.004
A105	.108	.102	.1050	.002	.006	.002	.002	.002	.002	.006
A106	.108	.103	.1055	.002	.004	.001	.001	.003	.003	.008
A107	.107	.102	.1039	.003	.004	.001	.002	.003	.004	.008
A108	.108	.102	.1050	.002	.005	.001	.002	.003	.002	.003
A109	.108	.103	.1046	.003	.005	.001	.001	.004	.006	.012
A110	.107	.102	.1040	.004	.005	.001	.002	.006	.007	.012
A111	.107	.103	.1046	.002	.004	.001	.002	.003	.003	.007
A112	.107	.101	.1038	.003	.005	< .001	.002	.004	.007	.008
A113	.108	.103	.1049	.003	.005	.001	.001	.003	.002	.007
A114	.108	.101	.1038	.004	.007	< .001	.002	.004	.008	.015
A115	.109	.103	.1050	.003	.006	< .001	.002	.004	.005	.008
A116	.109	.102	.1049	.004	.005	.001	.002	.002	.003	.009
A117	.108	.101	.1044	.003	.005	< .001	.002	.003	.005	.010
A118	.109	.104	.1056	.004	.005	.001	.002	.003	.004	.004
A119	.108	.103	.1052	.003	.005	.001	.002	.003	.006	.015
A120	.108	.103	.1055	.002	.004	< .001	.002	.006	.006	.007
A121	.108	.103	.1060	.002	.004	.002	.002	.002	.006	.013
A122	.109	.104	.1065	.002	.005	.002	.002	.004	.003	.006
A123	.109	.104	.1063	.002	.005	.002	.002	.003	.001	.008
A124	.110	.103	.1065	.004	.006	.002	.002	.004	.001	.016
A125	.109	.101	.1052	.003	.007	.002	.002	.003	.006	.012
Avg.	.1083	.1029	.1053	.0027	.0048	.0013	.0019	.0038	.0050	.0080
Std. Dev.	±.0012	±.0014	±.0006	±.0003	±.0012	±.0007	±.0002	±.0014	±.0025	±.0038

Notes:
1. Base datum is .484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.

Table XV
Penetration Data
DRB398HW3 Item 1 Copper, Drawn Cones
At Various Standoff Distances and Spin Rates

Round No.	Comp. B (lbs)	Standoff (inches)	Rotation (rps)	Penetration (inches M.S.)	Max Spread (in.)	Std. Dev. (in.)
A81	2.52	7.5	0	22.00		
A82	2.50	7.5	0	21.06		
A83	2.52	7.5	0	20.50		
A84	2.52	7.5	0	21.44		
A85	2.52	7.5	0	20.69		
				Avg. 21.14	1.50	±.60
A86	2.52	15.0	0	21.44		
A87	2.52	15.0	0	21.75		
A88	2.52	15.0	0	20.62		
A89	2.52	15.0	0	21.56		
A90	2.52	15.0	0	21.94		
				Avg. 21.46	1.32	±.51
A91	2.50	30.0	0	14.50		
A92	2.52	30.0	0	15.12		
A93	2.50	30.0	0	19.94		
A94	2.52	30.0	0	20.56		
A95	2.50	30.0	0	20.75		
				Avg. 18.77	6.25	±3.09
A96	2.50	7.5	15	20.44		
A97	2.52	7.5	15	17.50		
A98	2.52	7.5	15	19.81		
A99	2.52	7.5	15	18.81		
A100	2.50	7.5	15	20.62		
				Avg. 19.44	3.12	±1.29
A106	2.50	15.0	15	19.56		
A107	2.52	15.0	15	19.56		
A108	2.52	15.0	15	20.25		
A109	2.50	15.0	15	16.56		
A110	2.52	15.0	15	19.00		
				Avg. 18.99	3.69	±1.44
A116	2.52	30.0	15	16.69		
A117	2.50	30.0	15	15.44		
A118	2.52	30.0	15	17.00		
A119	2.52	30.0	15	12.38		
A120	2.50	30.0	15	18.62		
				Avg. 16.03	6.24	±2.33
A101	2.54	7.5	30	14.44		
A102	2.52	7.5	30	13.81		
A103	2.50	7.5	30	14.50		
A104	2.50	7.5	30	12.56		
A105	2.52	7.5	30	15.25		
				Avg. 14.11	2.69	±1.00
A111	2.52	15.0	30	10.19		
A112	2.52	15.0	30	11.19		
A113	2.52	15.0	30	13.38		
A114	2.52	15.0	30	10.75		
A115	2.50	15.0	30	12.62		
				Avg. 11.63	3.19	±1.34
A121	2.52	30.0	30	9.31		
A122	2.52	30.0	30	9.44		
A123	2.50	30.0	30	6.25		
A124	2.52	30.0	30	8.81		
A125	2.50	30.0	30	6.62		
				Avg. 8.09	2.82	±1.53

Notes:
1. DRB398 HW3 Item 1 Drawn, Copper Cones were assembled into DRC376 test bodies using a No. 2 nose ring.
2. All rounds were loaded at Ravenna Arsenal RAT Lot No. 43 with Comp. B Holston Lot No. 4-1197.
3. All rounds were fired at the Erie Ordnance Depot at the above listed standoffs and spins.

Future Program

1. Composite Cone Study

A series of bimetal cones with aluminum half shell inserts (.020 in. thick) and copper outer shells (DRB398HW3 item 1) will be assembled to evaluate penetration performance at standoffs of 2, 4 and 6 inches. A spin study is also planned.

2. Evaluation of Cones Made By Electroforming.

A series of DRB268-5 copper cones, made by an electroforming method, have been manufactured for comparison with machined cones of like design.

3. The Effect of Rotation on Aluminum Cone Performance.

A series of DRB398 HW3 item 1 and item 4 cones, machined from 2SF aluminum bar stock, will be tested for penetration at various spin rates (0, 30, 45 and 60 rps at 7.5 in. standoff. Another series will be rotated at the same velocities but at the optimum standoff of about 42 inches.

4. Penetration Into Mild Steel Versus Homogeneous Armor.

A series of penetration test rounds composed of DRB398 HW3 Item 1 cones in DRC376 test bodies were loaded and will be fired at various standoffs and rotations to determine the effect of these factors upon the penetration ratios for mild steel and homogeneous armor.

5. Evaluation of Cones Made By Zinc Die Casting.

A series of DRB398 HW3 cones are being made by die casting zinc alloy Zamak 3. Standoff and spin tests are planned.

6. Damage After Penetration

A series of rounds will be fired through prescribed thicknesses of target plate into an instrumented box. An effort will be made to record the temperatures and pressures in the box. Various types of cones will be used,namely copper, bimetal copper plus aluminum, aluminum and zinc. Similar tests are also planned in which damage to witness plates beyond the target will be evaluated.

7. Evaluation of the DRB398 HW3 Item 1 Copper Drawn Cones In Various States of Manufacture.

A series of cones have been obtained having varying geometric configurations. These cones represent the various steps in the deep drawing of the DRB398HW3 Item 1 copper cone. Six of the 8 drawing stages are included. A standoff and spin program is planned.

Graze Sensitivity Of The T222 Fuze Assembly

Methods for improving the sensitivity of the T222*fuze assembly (see Fortieth Progress Report, page 42) to ground and graze impact are still being studied. The Fortieth Progress Report contained the test data for two experimental designs being considered. A third design, known as the "potted lucky" design, was tested this month. Seven nose caps containing barium titanate crystals "potted" in thin aluminum caps were obtained from the Sprague Electric Co. These nose assemblies were fitted to T119E11 HEAT projectiles as shown in Fig. 13, and were fired by Mr. Farrell of the Recoilless Rifle Section, Development and Proof Services, Aberdeen Proving Ground. Ten standard T119E11 rounds with grooved caps, Fig. 14, were fired as controls. Five projectiles of each type were fired against homogeneous armor plate inclined at an angle of 64.5° at a range of 400 feet. The surface was sloped away from the line of fire. Five control rounds and two rounds containing "potted luckies" were fired from the BTD area to the 9600 yard area at APG, the nominal distance of flight being 4000 yards. Table XVI shows the results of the tests as reported unofficially by an observer from The Firestone Tire & Rubber Company.

The penetrations measured were 15.5 in. in each case. At long range, both of the potted nose elements functioned against soft earth, but none of the standard rounds functioned. On the basis of this small sample the rounds with "potted lucky" nose cap assemblies appear to be much superior in ground impact sensitivity to the rounds equipped with grooved nose caps.

A larger sample of "potted lucky" nose cap assemblies will be tested at 4000 yards and at graze impact at shorter ranges.

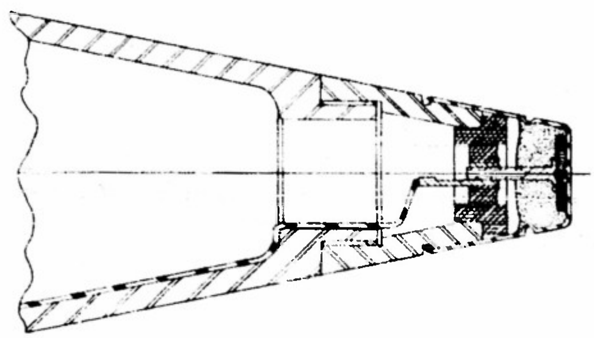


Fig. 13. T119E11 Ogive Assembly.
With Potted Nose Element.

*Any fuze system for a BAT HEAT round, assembled by Firestone is designated T222, regardless of component parts. Fuze systems assembled into projectiles at Firestone, using T208 base elements and any of various nose element assemblies are still designated T222 with appropriate dash number to signify the modification.

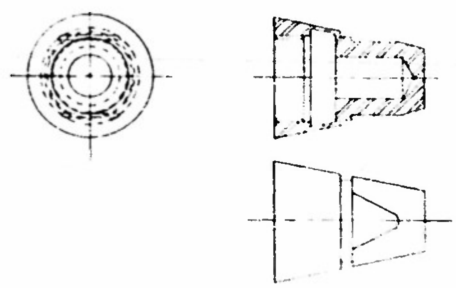


Fig. 14. Grooved Nose Cap.
For T119E11 Projectile Tests.

Table XVI
Graze Sensitivity Tests

Rounds fired from a T-170 Rifle #3 at plate set at 64.5° at a range of 400 ft.

Projectile Number	PA E Lot No.	Penetration (inches)	Remarks
X1479	13907	14.4	
X1487	13907	16.4	T119E11 Projectiles with
X1475	13907	14.1	"potted lucky".
X1481	13907	16.4	
X1480	13907	16.4	Avg. 15.5
13875	13906	16.4	
13877	13906	14.1	T119E11 Projectiles with standard
13878	13906	16.4	lucky and grooved nose cap.
13873	13906	16.4	
13882	13906	14.1	Avg. 15.5

Rounds fired from BTD area to 9600 yard range using T-170 rifle #3. (Nominal distance of projectile travel = 4000 yards).

Projectile Number	Elevation (mils)	Detonation on Impact	Hit Location	Range in Yards (Est.)	Remarks
15881*	200	FTF**	Not Observed	--	Lot PAE 13906 Grooved Cap
13874	190	FTF	9700	4100	
13880	190	FTF	9350	3750	
13879	190	FTF	9250	3650	
13876	190	FTF	9275	3675	
X1488	190	HO	9250	3650	Lot PAE 13907 with
X1483	190	HO	9250	3650	potted lucky

*Probably an error in projectile number.
**FTF=failed to detonate on striking ground.

T267E14 Fuze

All components for 100 T267E14 model 2 fuzes, Fig. 15, have been received. Assembly has begun and test firings both at Erie Ordnance Depot and Aberdeen Proving Ground are planned for the near future.

Drawings are completed for a fuze having all the features of the T267E14 model 2 fuze but of a reduced size. A pilot model will be fabricated for use in static tests.

Premature Functioning Of Electrically Fuzed HEAT Shell

A conference held at Picatinny Arsenal on methods for preventing prematures in electrically fuzed HEAT shell lead to the initiation of a program to devise a method for producing prematures in rounds equipped with Frankford Design D Crystals. A device for producing prematures in these rounds has been designed and tests will be made when projectiles become available.

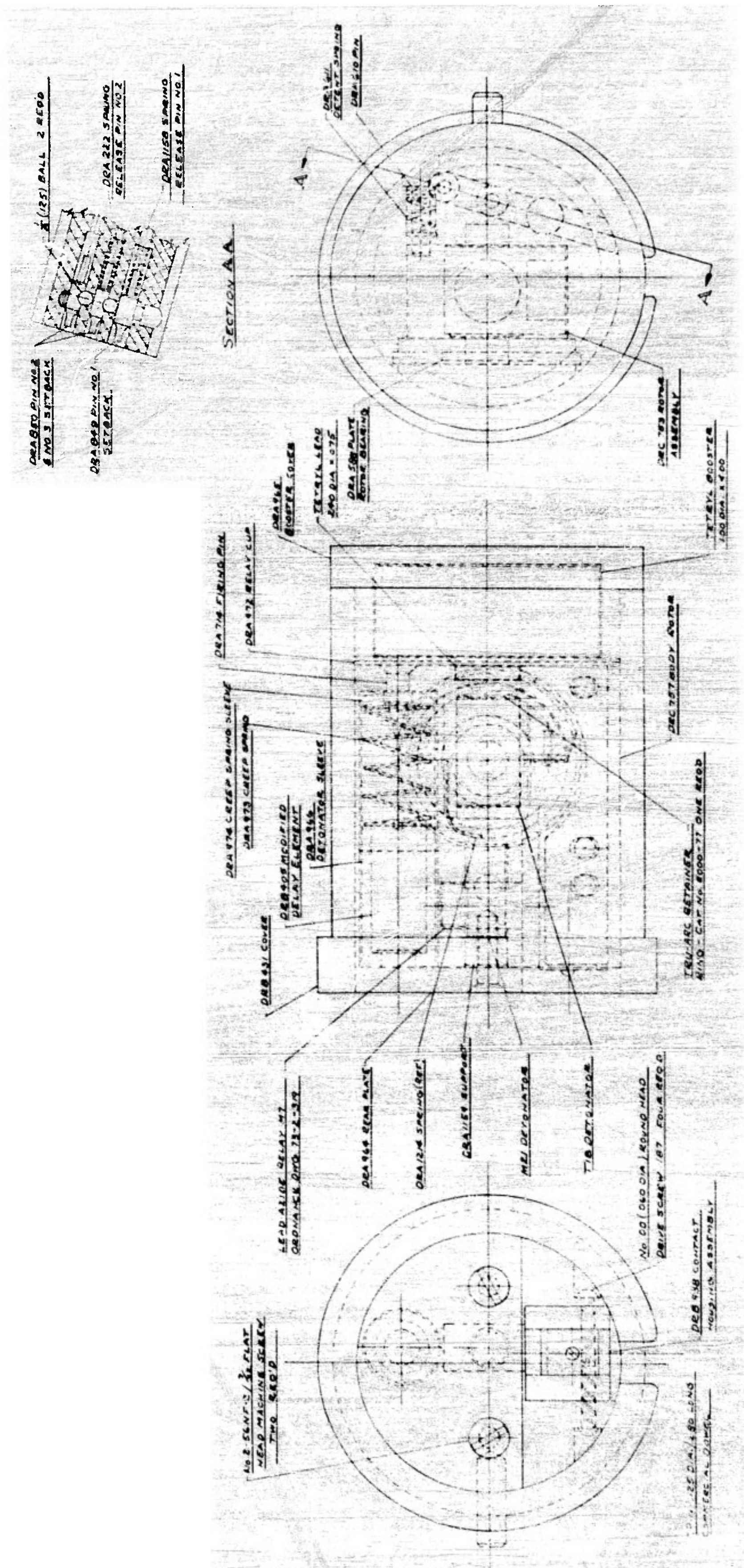


Fig. 15. T267E14 Model 2 Base Element.

T317 MT Fuze

The point detonator assembly for the T317 MT is shown in Fig. 16 (DRD438). The design of this assembly is based on the point detonator assembly (Ordnance Drawing FF4357) used with the M500 time fuze, and is intended to produce a point detonator whose arming initiation would depend upon setback alone, and be independent of spin.

The arming of this point detonator is controlled by a three pin setback system, such as that used in the Firestone Base Element, which is described in the Eighth Progress Report. After the third pin functions, the spring-loaded detent pin is free to move, releasing a spring-loaded brass slider. The slider is guided to, and stopped at, the armed position by the guide screw. The M22 detonator is initiated with the same firing pin assembly (FB31180) used in the ordnance point detonator (FF 4357).

Component parts for ten timing movements for the T317MT fuze have been received. The gear train does not roll as freely as desired and one assembly is being analyzed with a shadowgraph system.

Future Program

1. Test fire, for functioning evaluation, T267E14 base elements at Erie Ordnance Depot and Aberdeen Proving Ground.

2. Fire additional T119E11 projectiles, equipped with "potted luckies", at various ranges to test ground impact sensitivity.

3. Continue the development of a method for producing prematures with rounds equipped with the Frankford Design D Crystals.

4. Using the premature producing device of (3) above, determine the minimum resistance permissible in RC washers.

5. Test time fuze assemblies for functioning, using non-destructive laboratory tests.

6. Test functioning of point detonators with bursting screen firing.

7. Measure arming time of point detonator.

8. Analyze operation and functioning of timing movement.

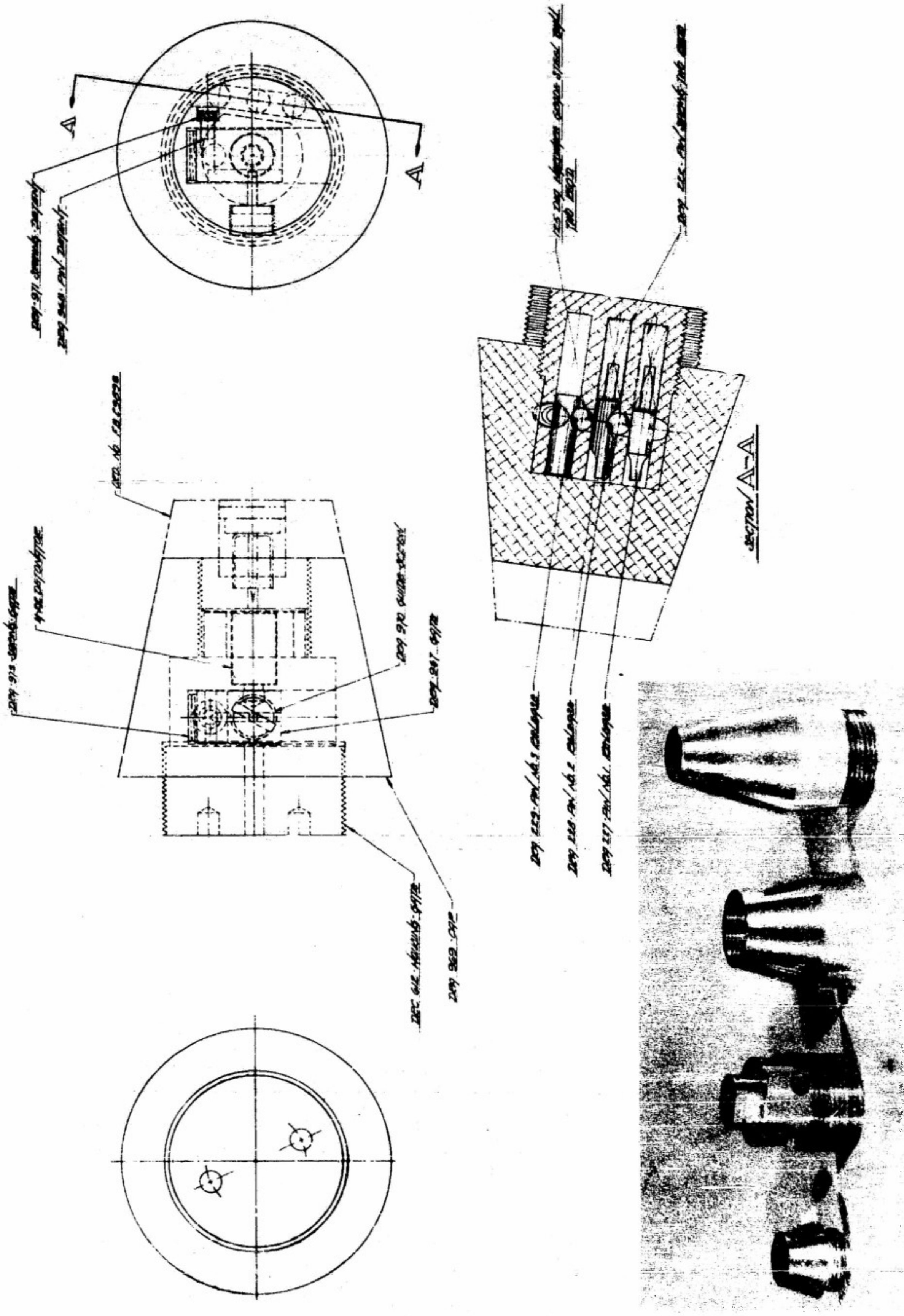


Fig. 16. Point Detonator Assembly.
T317 MT Fuze; Firestone Dwg. No. DRD438.

MANUFACTURING SUMMARY

In addition to the experimental material prepared for the research and development work under contracts DA-33-019-ORD-33 and DA-33-019-ORD-1202, described in preceding progress reports and in the preceding pages of this report, the following have been manufactured and shipped to the installations indicated.

Firestone's Defense Research Division, in shipping these items, transfers custody and control of the items to the receiving agencies. However, personnel of Defense Research Division will continue to collaborate with personnel of the other installations.

I. Cartridges, HEAT, 106mm, M344 (T119E11) Without Fuzes T208E7

Prior to	January 1, 1954	13,215	All Shipments
	January 8, 1954	500 (Inert)	Picatinny Arsenal
	January 8, 1954	250 (Live)	" "
	January 20, 1954	500 (Inert)	" "
	January 20, 1954	250 (Live)	" "
	January 28, 1954	500 (Inert)	" "
	January 28, 1954	250 (Live)	" "
	Total	15,465	

II. Rifles, T170E1 for ONTOS

Prior to	January 1, 1954	69	All Shipments

No Shipments in January

III. Mounts, T173 and T26 Tripod for ONTOS

Prior to	January 1, 1954	22	All Shipments

No Shipments in January

IV. BAT Systems less Jeep, T170E1 (M40) Rifle, T149E3 (M79) Mounts (with latest modifications).

Prior to	January 1, 1954	25	All Shipments

No Shipments in January

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